SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1922.

GENERAL PHYSICS.

2359. *Determination of the Coefficient of Rigidity of a Glass Plate.* **J. E. P. Wagstaff.** (Cambridge Phil. Soc., Proc. 21. pp. 59–65, May, 1922.)—An interference method is described for determining the rigidity of a glass plate. The glass is in the form of a beam 10 to 15 cm. long, of rectangular section, having a width of 1·8 cm. and a depth of 0·18 cm. approximately. The surfaces of the beam are reasonably flat, and give broad straight fringes when placed in contact with an optically flat surface. One end of the beam is clamped, and the other end is fastened to a cross-piece which can be rotated. A piece of optically worked glass rests on a small table, which can be accurately adjusted in height, so that a very thin film of air separates this plate from the beam, the two being at right angles. Adjustments are made so that broad fringes are obtained when a pure couple is applied to the beam. A number of rectangular hyperbolas are formed, and the rigidity of the plate is determined by the measurement of these curves. W. R. C.

2360. *On the Rotation of Slightly Elastic Bodies.* **D. Wrinch.** (Phil. Mag. 44. pp. 30–42, July, 1922.)—Mathematical.

2361. *Primary Standards of Length.* **A. Pérard.** (J. de Physique et le Radium, 3. pp. 252–260, July, 1922.)—Describes measurements on a series of quartz standards of length, prisms of 25 mm. square at each end, and 1, 2, 3, 4, 5, and 10 cm. in length. The work was carried out at the Bureau International des Poids et Mesures, the method employed being described in detail in the paper. The Michelson interferometer was used without any silvering of the faces of the quartz prisms. Two methods of measurement were employed. The uncertainties in the measurements did not, in general, exceed about 0·01 μ. Values of the refractive index of quartz (ordinary ray) are given in the paper, the absolute values for M_i (indigo Hg) and C_r (cadmium red) being respectively $1{\cdot}554, 311, 4 - 5{\cdot}56 \times 10^{-6}\theta$ and $1{\cdot}542, 801, 4 - 6{\cdot}15 \times 10^{-6}\theta$. J. W. T. W.

2362. *Apparatus for Determining the Standard Deviation Mechanically.* **W. L. Balls.** (Roy. Soc., Proc. 101. pp. 333–341, July 1, 1922.)—The calculating apparatus here described is a natural development from the "harp" harmonic analyser [Abs. 1645 (1921)], and similarly makes use of loaded strings which apply forces to a flexible yoke, whose consequent movement resolves these forces automatically. The use of vertical strings in place of the horizontal ones employed in the "harp" made it possible to design the apparatus to give quantitative amplitudes to the yoke movements, which in the "harp" were only qualitative. The purpose of the apparatus is to enable tolerably precise calculations of standard deviation and other related statistical constants to be made quickly by persons other than trained computers. The loads on the strings are so arranged that the apparatus applies the method of least squares mechanically. The apparatus, full details of which are given, is simple and inexpensive to construct, simple and quick in use, and retains its sensitivity and zero indefinitely. A. W.

2363. *High-Speed Oscillograph Camera as Chronograph.* **E. A. Eckhardt.** (Frank. Inst., J. 194. pp. 49–67, July, 1922.)—Problems demanding the use of high film speeds and precise time scales have led to the development of the high-speed oscillograph camera here described, which, with its associated time-scale apparatus, has proved very convenient and effective for research. The film is on a drum and clamped tightly in position by a special device consisting of a stud which receives the ends of the film in a cross slot, and by a quarter turn tightens and fixes it. The camera is actuated by electrical circuits and relays, of which a full wiring diagram is given. The paper also includes other diagrams, graphs, and photographs of the apparatus. E. H. B.

2364. *Accurate Measuring Machine.* **H. Baker.** (Engineer, 134. pp. 81–83, July 28, 1922.)—Using a machine of the Societé Genevoise make, with the endeavour to attain consistent work to 1/10th micron, the author finds many precautions necessary, as follows:—Wipe all surfaces first with dry wash leather, then with wash leather moistened with ether, then inspect the surface with a mirror and pocket lens, and remove with a pocket-knife any specks still adhering to the surfaces. Cover the machine and surfaces used with a large wash leather to exclude dust. A peculiarity of the machine may be found due to too great displacement of the tail anvil before a measurement. To reduce error due to thickness of the oil film in the micrometer screw a steady pressure of 20 lbs. is used to thrust the screw back on its stop. If the pressure be varied the results indicate not a true elastic effect as anticipated, but a cyclic one, indicating deflection of the frame of the instrument under the varied stresses. The micrometer screw anvil is lightly tapped back before a reading is taken. This facilitates settling, but a main cause of settling is due to temperature, since the presence of the observer and friction of the micrometer screw cause rise of temperature in and about the measuring surfaces. The author summarises the conditions necessary for the desired accuracy:—(1) Temperature of the room constant to ⅛° C. for four hours before a reading. (2) The specimen must be geometrically accurate to less than ¼ micron, or the alignment of it must be exceedingly nearly constant. (3) All measuring surfaces clean; no dirt visible with a 4-power microscope. After rubbing any surface, leave it two hours before a reading. (4) Do not touch or breathe on the machine, keep the body at least 1 foot away, and wear gloves, remaining in front of the machine for the minimum time. (5) Temperature of the room must not vary more than ⅛° C., except for short periods, while measurements are made. (6) If the screw has to be moved more than three revolutions the machine should be left one hour to settle. (7) The "tail pointer" in this type of machine should not be moved far from zero.

P. E. S.

2365. *Pressure Gradient in Liquids Flowing through Cones.* **W. N. Bond.** (Phys. Soc., Proc. 34. pp. 189–196; Disc., 196, Aug., 1922.) —By experiments on the flow of water through ambroid tubes, the pressure-drop over a measured length being observed for flow at various speeds, and in both directions, the pressure gradient due to "losses," i.e. viscosity and eddies, was separated from that due to variation of velocity on account of convergence. The "losses" are found to be practically the same for a cone of small angle (4° 2′ was the greatest used) as for a parallel walled tube. There is, however, an abnormally large "loss" in diverging flow at small speeds, which is at present unexplained.

W. G. B.

2366. *The Use of Very Small Pitot Tubes for Measuring Wind Velocity.* **M. Barker.** (Roy. Soc., Proc. 101. pp. 435–445, Aug. 1, 1922.)—This paper describes the results of a theoretical, and an experimental investigation of the law of flow of a fluid close to the wall of a pipe, bearing upon the results of some experiments by Stanton and Marshall on air in turbulent flow. In the latter experiments, a Pitot tube was used which had one side only, the other being replaced by the wall itself, so that the "v" to be used in the formula $p = \frac{1}{2}\rho v^2$, was an intermediate value between zero and the velocity at the outer wall; in other words, the "effective distance" between the Pitot tube and the wall was less than the total opening of the one side of the Pitot tube.

In the theoretical investigation it was assumed that the pressure at the centre of Stanton's one-sided Pitot tube was the same as that at the nose of a sphere, of the same diameter as the Pitot tube opening, when placed in a stream moving at a velocity equal to that at the centre of the Pitot opening. By an application of Stokes' law it is shown that this assumption leads to the relation $d' = \sqrt{\frac{3\mu a}{2\rho v_0}}$, where d' is the effective distance, μ the viscosity coefficient, a the radius of the pipe, $2d$ the breadth of the Pitot opening, v_0 the velocity at the centre of the pipe, and ρ the fluid density. The results obtained by substituting the appropriate values used in Stanton's experiments are compared with Stanton's experimental values, and the deduction is made that the effective distance is not independent of the velocity, as the curve based on the experimental results would appear to indicate, but that the v^2 law breaks down for small Pitot tubes. The results of an experimental investigation on the pressures and velocities of flow of water moving at low velocities, that is, in streamline motion, are next considered, and it is shown that the law $p = \frac{1}{2}\rho v^2$ held down to a velocity at the centre of the pipe of 6 cm. per second, that is for values of rv/γ greater than 30 (γ being the kinematical velocity, and v the velocity at the centre of the Pitot opening). For values of v of less than 6 cm. per second, the pressure differences (between the static and dynamic openings) were greater than those given by the v^2 relation, thus indicating a viscosity effect, which was evident as an additional pressure. On the previous assumption of a sphere, it is shown that this additional pressure value p_1 is given by $p_1 = \frac{3}{2}\mu v/r$, and that the total pressure difference $p = \frac{1}{2}\rho v^2 + p_1$. On plotting the experimentally observed pressures p against the values calculated from this theoretical relation a straight-line graph was obtained, thus indicating the accuracy of the theoretical relation. It is pointed out that the value of rv/γ of less than 30 is applicable to the conditions of Stanton's experiments, and that a viscosity effect was therefore involved in the results. A detailed account is given of the experimental apparatus, and methods employed, with a concluding suggestion for further experiments, using liquids of higher densities than water, in order to obtain more accurate results of the viscosity effect. **A. W. J.**

2367. *The Breaking Stress of Crystals of Rock Salt.* **G. N. Antonoff.** (Phil. Mag. 44. pp. 62–66, July, 1922.)—In a previous paper [see Abs. 132 (1919)] the author has developed a theory of surface tension under the assumption that the attraction of molecules is due to electrical or magnetic forces, or both. Instead of assuming a uniform field round the molecules, as according to Laplace, the author regarded the molecules as electrical doublets, and from the theory of potential deduced that the attraction between them must be inversely proportional to the 4th power of the distance, provided the distance between the doublets is large compared with their respective lengths. The intrinsic pressure was shown to be derivable from the surface tension when the molecular weight of the liquid was known. These results are now applied to the crystalline state for the purpose of evaluating the surface tensions of solids, as no direct experimental method exists. The method employed determines the internal pressure per cm.^{2}, if the molecular structure of the crystalline substance be known, and for the latter purpose the X-ray analysis results of W. H. and W. L. Bragg for rock salt are utilised. Experimental details are briefly described. If the attraction between the charges in a row is not appreciably influenced by the adjacent rows, a value of 1·4 dynes per cm. is found to represent the surface tension in the direction coinciding with the vertical axis. If the field is symmetrical in all 3 directions parallel to the main axes, this figure holds for all, but unfortunately is about 1000 times less than expected. The author concludes that the figure 1·4 dynes per cm., although quite characteristic for the substance, is not the actual value of the force in the surface layer, but calculation is difficult owing to the very slowly converging series which occur. **H. H. Ho.**

2368. *The Unsteady Motion Produced in a Uniformly Rotating Cylinder of Water by a Sudden Change in the Angular Velocity of the Boundary.* **A. R. McLeod.** (Phil. Mag. 44. pp. 1–14, July, 1922.)—Compares observed angular velocities with those calculated (neglecting effects of base and surface) for the unsteady motion in which a cylindrical vessel containing water is suddenly started rotating, or suddenly stopped when, with the water, it is rotating uniformly. With a small cylinder, good agreement was obtained (diam. 5 cm.), but this was not so for larger cylinders (up to 25 cm. diam.). Also, the agreement was worse for "stopping" experiments than for "starting" ones. Causes of this are discussed, but no very definite conclusion is reached. **W. G. B.**

2369. *The Resistance to the Motion of a Solid Sphere in a Viscous Liquid Enclosed between Parallel Walls.* **H. Faxén.** (Ann. d. Physik,

68. 2. pp. 89–119, July 20, 1922.)—The formula deduced by a lengthy process of successive approximation, for the resistance, R, experienced by a sphere of radius a, moving with velocity v in a liquid of viscosity μ, between two parallel walls, $2l$ apart, is: $R = 6\pi\mu av/(1 - 1\cdot004a/l + 0\cdot418a^3/l^3 - 0\cdot169a^5/l^5)$. W. G. B.

2370. *On the Rotating Moment of a Sphere which is Rotating in a Uniform Electric Field.* **Y. Ikeda.** (Phys. Math. Soc., Japan, Proc. 4. pp. 101–105, June, 1922.)—The assumption is made that a dielectric conducting sphere is rotating in a uniform electric field whose direction is perpendicular to the axes of rotation. The distribution of the charge on the sphere is first investigated, and followed by an examination of the moment of rotation due to the field. The paper itself is mathematical throughout. H. H. Ho.

2371. *Gyratory Compasses.* **M. Schuler.** (Zeits. Math. u. Mechanik, 2. pp. 233–250, Aug., 1922.)—A mathematical discussion of gyratory compasses in relation to the swing of the ship. The types dealt with are Anschutz (single wheel), Sperry (double), and Anschutz (triple). Details of some German Admiralty tests, made in 1912, are given. A. D.

2372. *Inertia and Gravity.* **R. v. Eötvös, D. Pekár, E. Fekete.** (Ann. d. Physik, 68. 1. pp. 11–66, July 20, 1922.)—Using the well-known torsion balance of Eötvös, described in 1906, and following the methods indicated by that author, the present authors describe a variety of experiments on the behaviour of the torsion balance loaded with varying materials. Let it be assumed that κ is a coefficient of gravity, i.e. that $\kappa = (f' - f)/f$, where f' is the gravitation constant for some material, say platinum, and f is that for some standard material, say water. Then it is shown that $\eta = -\frac{G}{g}\,.\,\kappa \sin \epsilon$, where G is the actual gravity pull on the non-standard material, g is the gravity (which includes the centrifugal force as well as the gravity pull), ϵ is the inclination of the plumb-line for the standard material, and η is the difference found in this inclination between the standard and non-standard materials. If κ is actually $= 0$, η vanishes, and in that case inertia is strictly proportional to gravity. Newton's pendulum work established this proportionality to accuracy 1/1000, Bessel's pendulum work brought the figure to 1/60,000, whereas, using the torsion balance, Eötvös reduces it to 1/20,000,000. The last figure would involve a difference in inclinations of two plumb-lines (one of the standard and the other of the non-standard) of only 0·000018 second of arc. Some results found by the authors are:

(1) Values of κ range from $-0\cdot006\,.\,10^{-6}$ for water to $+0\cdot004\,.\,10^{-6}$ for copper. Other materials used were magnalium, platinum, copper sulphate (solid and solution), asbestos, talc. The probable errors range from $0\cdot001\,.\,10^{-6}$ to $0\cdot003\,.\,10^{-6}$.

(2) The Landolt reaction of silver sulphate and iron sulphate, the materials being tried before and after reaction, show difference *null*, i.e. $= 0\cdot000\,.\,10^{-6} \pm 0\cdot002\,.\,10^{-6}$. And for Heydweiler's effect of dissolving copper sulphate the difference effect is $= 0\cdot002\,.\,10^{-6} \pm 0\cdot002\,.\,10^{-6}$.

(3) For observation on the sun's attraction, using the same methods, but in meridian, the coefficient difference between platinum and magnalium is $+0\cdot006\,.\,10^{-6}$.

(4) The absorption of a plate of lead of 5 cm. thickness is less than $0{\cdot}00002 \,.\, 10^{-6}$.

(5) Using a radium preparation of 0·20 gm. the coefficient is found to be of the order $-0{\cdot}25 \,.\, 10^{-6} \pm 0{\cdot}50 \,.\, 10^{-6}$. P. E. S.

2373. *Pseudo-Regular Precession.* **G. Greenhill.** (Phil. Mag. 44. pp. 179–193, July, 1922.)—Discusses the motion of a top when the axle describes a crinkled curve of small loops or waves. Mainly mathematical, and not easily abstracted. W. G. B.

2374. *The Electric Theory of Solids.* **M. Brillouin.** (Soc. Franç. Elect., Bull. 2. pp. 303–326, June, 1922.)—Not even the qualitative results of the astronomical theory of perturbations can be applied to the electrons circulating in the atom, since these repel one another, while the planets attract. There is no tendency for the orbits to approach a common plane; on the contrary, when there are only two electrons, the two orbit planes will repel one another, just like two charged gold leaves, and set themselves at right angles to one another. If there are three electrons the plane of each orbit will set itself at right angles to both the other orbits. Four electrons will have orbits perpendicular to the diagonals of a cube. This gives a tetrahedral distribution. For a large number of electrons the mutual repulsion will cause the orbits to be distributed throughout the space about the nucleus, the electrons being kept at a finite distance by the attraction of the nucleus, balanced by the centrifugal force. Landé has worked out a special case, with eight electrons. The coordinates x, y, z of the electron in the first octant of the axes determine those of the other seven; and the eight electrons move on the surface of a sphere about the nucleus. Two extreme cases are easy to deal with, and give an idea of what happens in other cases. If the charge of the nucleus is small, each electron moves, practically in a small circle, around the corner of a fixed cube. If the nuclear charge is very large, much greater than $8e$, the orbits of the electrons approach very closely to spherical triangles, with sides 60°, inscribed in each octant; the corners being rounded off, so that each electron still describes a regular path about one of the corners of a fixed cube. For such atoms, with cubical symmetry, the potential at a distance contains no terms in r^{-2}, r^{-3}, or r^{-4}, but terms in r^{-5} exist, which change at each instant with the phase of the electrons in their orbits, and have a mean value which differs from zero. The result is that the neutral atom repels another atom, the repulsion increasing rapidly when the distance diminishes. Two ions, one positive and the other negative, attract one another when the distance is large enough; but for small distances, of the order of four or five times the radius of the layer of electrons, they repel one another. At about double this distance the two forces balance one another, and the ions are in equilibrium. Such ions combine to build up a stable crystalline structure, with definite dimensions. The dimensions of the space lattice of a crystal thus depend on the "quantification" of the orbits of the electrons. Born has calculated the dimensions of the space lattice of sodium chloride, adopting a planetary constitution for the ionised atoms, and the form of space lattice discovered by Bragg (Born, La Constitution de la Matière. Blanchard, 1922). The planes of the orbits were assigned orientations consistent with cubical symmetry, and the total energy of the system was determined. The distance between the atoms which makes this energy minimum was found, and agreed fairly well with the observed values. The same is true of the calculations made on the compounds of F, Cl, Br, and I with sodium and the other alkali metals, from lithium to cæsium. The small differences between the observed and calculated values are attributed to the fact that terms in r^{-7} and r^{-9} were neglected, and that the nuclei were supposed motionless, without temperature movements. Born has also studied the volume compressibility of some of these salts; but the potential law $V = a/r - b/r^5$ does not give the experimental values. $V = a/r - c/r^9$ gives very nearly correct results. Born has recently found that if the atom with cubic symmetry is substituted for Bohr's planetary atom, the term r^{-9} is the most important one for the repulsion of the atoms. The ratio c/a, however, has not been theoretically determined. The above value of V must, then, be regarded as largely empirical. Born's work was carried out before Landé's study of the atom with cubical symmetry. He has, however, considered the effect of substituting such an atom for that originally used; but found that there was no change in the order of magnitude of the result. Born and Landé communicated a common paper on the subject to the Physical Society of Berlin in November 1918. H. N. A.

2375. *Binding of Electrons by Atoms.* **J. W. Nicholson.** (Phil. Mag. 44. pp. 193–203, July, 1922.)—According to the quantum theory of atomic structure and of the emission of line spectra, the paths of the electron in the atom vary according to the particular coordinates used in the process of quantising the separate momenta. It is generally believed that the atomic energy is in all cases determinate and definite. It is here shown, however, that this conclusion requires modification when the path extends to infinity. The hyperbolic orbits of Epstein, which have been used extensively in the interpretation of certain groups of γ rays associated with many of the atoms, constitute an instance, and it is shown that they rest on a mathematical error, and that in fact it is not possible to preserve finite phase-integrals in the process of quantising the momenta. In fact, it appears that the whole process is only applicable to finite paths, and gives no clue to the phenomena taking place during the binding of an electron which comes from a considerable distance. A. W.

2376. *The Energy of Gaseous Molecules.* **J. R. Partington.** (Faraday Soc., Trans. 17. pp. 734–741; Disc., 742–747, May, 1922.)—The introduction to this very comprehensive paper deals with configuration and structure, which for the atomic nucleus has no appreciable influence on the molecular heats of gases, since the monatomic molecules of the 5 inert gases, of mercury vapour, and of dissociated iodine vapour, which have totally different nuclear structures, have identical energies, 2·98 T g. cal. per g. mol. The determining factor is the manner in which the molecule is built up of the nuclei of its constituent atoms and of surrounding electrons. The contribution of the electrons themselves, on account of their small mass, is negligible under all ordinary circumstances. The configuration of the molecule as a whole mainly determines its behaviour to impulsive forces of collision, but the internal motions of the parts of more complicated molecules may contribute an appreciable fraction to the energy. The behaviour of a molecule in collision depends almost entirely on the shape of the outer shell of electrons. The speculation suggests itself that the exchange of energy in ordinary collisions may be in quanta, which are proportional to the collision frequencies. It is thought possible that the laws of collision of molecules are not covered by a purely dynamical theory. Section 2 deals with the exchange of energy by collisions which is assumed to be divided up among the degrees of freedom of the molecules. Sections 3 and 4 consider the experimental results for monatomic, diatomic, and polyatomic gases. Section 5 deals with quantum theory which assumes that energy exchange occurs discontinuously. It is found that although the translational part of the energy is almost exactly equal to the equipartition value, at ordinary temperatures, the rotational part may depend on the former through a whole multiple relation between the frequencies, since the observed deviations would then depend on the rotational energies. Section 6 considers rotational and vibrational frequencies, and assumes that the former are whole multiples of translational frequencies, and that the latter are independent of T as in the case of solid bodies. Indirect evidence for both assumptions is quoted. Section 7 deals with the internal motions of molecules on Bohr's theory. A very critical and informing discussion followed the paper. H. H. Ho.

2377. *The Viscous Properties of Silicane.* **A. O. Rankine and C. J. Smith.** (Phys. Soc., Proc. 34. pp. 181–186; Disc., 186, Aug., 1922.)—Silicane, SiH_4, is a gas, and may be compared with methane, CH_4. The gases argon Ar, HCl, H_2S, PH_3, SiH_4 have the same molecular number, or the sum of the atomic numbers of their atoms is the same, namely 18. There are substantial grounds for believing that the central regions of all of them have practically the same dimensions, the differences in the mean collision areas of the molecules arising from external protuberances corresponding to the H atoms. This is deduced from the viscous properties of the first four of the gases, and to complete the investigation the viscosity of silicane has been determined. The method employed has been described by the authors [Abs. 271 (1922)]. The viscometer is filled with air, and then with silicane, and the times taken for the same mercury pellet to drive equal volumes of gas through the capillary tube are compared at ordinary and steam temperatures.

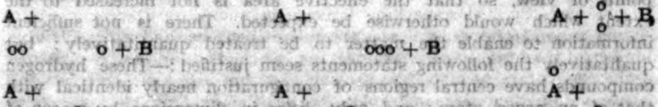
The method of preparing pure silicane by the action of HCl on Mg_2Si is described. SiH_4 and Si_2H_6 are formed, and as the mixture is spontaneously inflammable, the air in the apparatus has to be replaced by hydrogen, and the result is a mixture of SiH_4, Si_2H_6, and H. The silicon hydrides are solidified in a U tube, surrounded with liquid air, which is afterwards replaced by alcohol, cooled to $-80°$ C. by means of solid CO_2. This temperature is well above the boiling-point of silicane, which is thus evaporated, and comes over with some hydrogen. This was again condensed at liquid air temperature, the permanent gases were pumped off, and the silicane evaporated again at $-80°$ C. This process was repeated twice. The viscosities at 15° C. and 100° C. were found to be $\eta_{15} = 1 \cdot 134 \times 10^{-4}$ c.g.s. units and $\eta_{100} = 1 \cdot 436 \times 10^{-4}$ c.g.s. units. From these figures Sutherland's constant is calculated, $c = 229$, and the viscosity at 0° C., $\eta_0 = 1 \cdot 078 \times 10^{-4}$ c.g.s. units. These figures give the mean area presented for collision by the molecules in thermal agitation, by means of Chapman's formula, $A = 0 \cdot 989 \times 10^{-15}$ cm.^{2}. The ration of this area to that of argon is 1·53.

Each of the gases, SiH_4, PH_3, H_2S, and HCl, can be regarded as a system in which the stable configuration of extra-nuclear electrons of the argon atom has been attained, by the addition of a sufficient number of the single electrons of H atoms, the nuclei of the latter remaining external to the system. In SiH_4 four additional electrons are needed, since the atomic number of Si is four less than that of Ar. The differences in area are supposed to be due to the nuclei of the attached H atoms forming protuberances. The ratios of the collision areas are SiH_4 1·53, PH_3 1·41, H_2S 1·19, HCl 1·04, Ar 1·00. Thus the increase, which is small in passing from Ar to HCl, is greater in passing to H_2Si, still greater in passing to PH_3, but drops off somewhat in passing to SiH_4. It is assumed that the protuberances, for which the H nuclei are responsible, grow with increasing number, the nuclei retreating from one another, and from the centre of the molecule, on account of their mutual repulsion. The area which the molecule will present as a target, for any given orientation, will depend on the degree of mutual overlapping of the central nucleus and the prominences. When the number of prominences is small, they cannot overlap from any point of view; but when it is large, as in the case of silicane, there will be overlapping from certain points of view, so that the effective area is not increased to the extent which would otherwise be expected. There is not sufficient information to enable the matter to be treated quantitatively; but qualitatively the following statements seem justified:—These hydrogen compounds have central regions of configuration nearly identical with that of an argon atom; and only differ in dimensions by reason of the outlying H nuclei; the distances of the H nuclei from the centre of the molecule increase more and more rapidly as the nuclei multiply. *Discussion.*—**O. W. Richardson** asked if the results conflict with those obtained by X-ray measurement of crystal lattices. The authors replied that the conflict is apparent rather than real. The only point of contact between the two methods is afforded by the inert gases, the crystallographic diameters of whose atoms can be extrapolated from those of other elements in the same series. The dimensions to be measured are not the same in the two cases. In the viscosity experiments it must be assumed that the atoms approach one another, up to the distance at which the force between them changes sign, and becomes a repulsion. H. N. A.

2378. *On the Structure of some Gaseous Molecules of which Hydrogen is a Constituent.* **A. O. Rankine.** (Faraday Soc., Trans. 17. pp. 719–727; Disc., 728–733, May, 1922.)—Recently there has been a considerable accumulation of reliable data relating to the viscosity of gases whose molecules contain one or more hydrogen atoms; data which provides means of obtaining some knowledge of the dimensions of the molecules in question. An examination of 8 different hydrogen compounds has now been made, HCl, HBr, HI, H_2S, NH_3, PH_3, AsH_3, CH_4, from the point of view of their behaviour in molecular collision, and tables are given of the "mean collision areas." For a discussion of the significance of the latter term, Abs. 1240 (1922) should be consulted. Assuming that the atoms towards the end of each period of the periodic table are equal in size (evidence in support of this is given, based on W. L. Bragg's X-ray measurements), it is shown to be probable that as the number of hydrogen atoms in the molecule increases, their nuclei get more and more remote from the nucleus of the central atom. It is suggested that this retreat of the hydrogen nuclei is due to their mutual repulsion, and that the effect eventually leads to the failure to form such molecules, otherwise possible, as BH_3 and AlH_3. A comparison is made of the relative dimensions of CH_4 and Kr, which prove to be of the same size to a degree within that of probable experimental errors. The identity of correspondence between CH_4 and NH_4, as compared with that between Kr and Rb, is pointed out, and attention is drawn to the equality of domains occupied in corresponding crystals by NH_4 and Rb respectively. The results of estimates of molecular dimensions derived from viscosity measurements and from crystal measurements thus mutually confirm one another.

A valuable discussion followed. H. H. Ho.

2379. *Conjugation and the Structure of Benzene.* **M. L. Huggins.** (Am. Chem. Soc., J. 44. pp. 1607–1617, Aug., 1922.)—In another paper the writer shows that pairing, and in the heavier elements triplet formation in atomic shells, and the formation of electron bonds, may be explained by assuming that the repulsion between electrons obeys a law of force which makes it a maximum for a certain distance between them.



1. 2. 3.

Mechanism of a Simple Replacement Reaction.—Two positively charged atoms A and A are joined into a molecule by a single bond consisting of two electrons, as shown at 1, and an atom B, containing an unpaired electron in its valence shell, approaches. No. 2 shows how the three electrons come together; in the original paper they form an equilateral triangle with the apices pointing to A, A, and B; but for convenience in printing they are here shown in a straight line. No. 3 shows the upper + A and the + B joined by a single bond, and the lower + A united with one of the electrons, to form a neutral atom. When two molecules, $\mathrm{A} + \genfrac{}{}{0pt}{}{\mathrm{o}}{\mathrm{o}} + \mathrm{A}$ and $\mathrm{B} + \genfrac{}{}{0pt}{}{\mathrm{o}}{\mathrm{o}} + \mathrm{B}$, come together, the four electrons are shown forming a small square with the A's and B's at the corners of a larger square, having the same diagonals. This is supposed to represent a temporary union with a four-electron bond, and it breaks up quickly into two molecules $\mathrm{A} + \genfrac{}{}{0pt}{}{\mathrm{o}}{\mathrm{o}} + \mathrm{B}$. Similar explanations are given of the addition of the atoms of a molecule with a single bond to a molecule with a double bond, and the reaction between two compounds with double or triple bonds. In the last case a four-membered ring compound may be formed, an intermediate stage being assumed in which four electrons, at the centre of a square at the corners of which the four atoms are placed, form a multiple-electron bond. Under some circumstances multiple-electron bonds may have more than a temporary existence. In a "conjugated" system, represented by the general formula $A = B - C = D$, the bond, consisting of two electrons, represented by the upper dash between A and B links up with the two represented by the upper dash between C and D to form a group of four. Erlenmeyer has shown that the peculiar addition reactions of conjugated systems may be simply explained by assuming that they possess structures of this type. In the original paper the atoms, except hydrogen, are, from this point on, represented by tetrahedra, which, when unlettered, are carbon. What may be called "double conjugation" (general formula $A = B - C = D - E = F$) occurs in such compounds as hexatriene, fumaric acid, and malaic acid. In the first of these the carbon tetrahedra, which are not quite regular, are arranged so that six of their faces almost form a hexagon, which, however, does not quite close up, alternate tetrahedra pointing upwards and downwards. In benzene preference is given to Körner's centroid model, which is similar to that for hexatriene, but with the tetrahedra joining up to form a perfectly symmetrical model. It is evident that in order to break this up not one, but several, very tight bonds must be broken. The residual affinities of the outer electron pairs are not strong enough, by themselves, to hold other molecules, forming addition products; but they are strong enough to play a very important part in the orientation of substituting and substituted groups. The X-ray data obtained by Hull, and by Debye and Scherrer, indicate that graphite is composed of layers, which are exactly the same, both as regards the position of the carbon nuclei and of electrons, as would be obtained by "close-packing" benzene nuclei (of the centroid or Körner type). The molecules in crystals of benzene, and a considerable number of its derivatives, are similarly close packed, and the dimensions of the elementary hexagon are the same, within a few per cent., as the corresponding dimensions in graphite. The other evidence for and against this structure is briefly reviewed, and it is shown that the objections raised to it are all invalid, or inconclusive, and the known properties of benzene, and its derivatives, are found to be very adequately represented by their centroid structure. **H. N. A.**

2380. *Application of the Octet Theory to Single-Ring Aromatic Compounds.* **E. C. Crocker.** (Am. Chem. Soc., J. 44. pp. 1618–1630, Aug., 1922.) —In the first stages of the evolution of the theory octets were considered as necessarily cubical. This was of great value, for it plainly indicated two different types of combination; the shared pair of electrons, or non-polar "bond"; and the electrostatic attraction between complete charged octets, or octets and hydrogen kernels; or ionic combination. It also made it clear that "pentavalent" nitrogen does not have 5 organic-type bonds. Lewis soon decided that the octet was more likely to be tetrahedral than cubical; the cubical form of carbon is not compatible with optical activity, which demands atoms essentially tetrahedral. This type demands electrons arranged more or less in pairs, and it is suggested that Parson's magneton theory may afford an explanation of this. A model is suggested for benzene in which six short equilateral prisms are built up round an hexagonal prism, each of the equilateral prisms representing a carbon atom, joined to each of the two neighbouring prisms by a bond of two electrons, and to the H nucleus on its outer edge by a similar bond. This only gives six electrons round each carbon nucleus, and it is supposed that, in the space between each pair of carbons, there is a single "aromatic" electron, which is held in equilibrium by the repulsions of the other five aromatic electrons, and by the attraction of the positively charged nuclei. It is to be expected that, if some other element or radical replaces H on one carbon, the average positions of the aromatic electrons will be different from those in plain benzene. If any one aromatic electron moves from its position, midway between the carbons, the electrical equilibrium is disturbed, and the others must move in such a manner as to restore it. If the electrons nearest to C_1 are attracted towards it, more than they were in benzene, the remaining 4 will group round C_3 and C_5. If on the other hand the substituent of H on C_1 does not attract the electrons as much as H, the groupings would be round C_2, C_4, and C_6. The first pattern is known as *o.p.*, and the second as *m*. Toluene with CH_3 on C_1 gives pattern *o.p.*; nitrobenzene with NO_2 on C_1 gives pattern *m*; an octet of large "effective" kernel charge such as Cl (7) on C_1 gives pattern *o.p.* (effective charge of H is 1, of C 4, of N 5, of O or S 6, and of the halogens 7). In pattern *o.p.* the displacement of the aromatic electrons increases their attraction for the H atoms on C_3 and C_5, and diminishes that for those on C_2, C_4, and C_6. Positions 3 and 5 are virtually closed, as far as substitution is concerned, and positions 2, 4, and 6 are open, with the hydrogens much more lightly held. In chlorobenzene, phenol, aniline, and toluene, one would expect ortho-para substitution, with not more than traces of meta products. This agrees with the known facts. Certain other radicals at C_1 may be expected to produce pattern *m*, giving only meta substitutions. Relative ease of substitution into the various substituted benzenes is treated as a result of polarity considerations, which are developed as an essential consequence of the octet theory, and an addition to the above aromatic structural considerations. Preference for substitution in ortho versus para positions is treated in the same way. H. N. A.

2381. *Theoretical Aspects of the Neon Spectrum.* **L. S. C. Broughall.** (Phil. Mag. 44. pp. 204–214, July, 1922.)—In a previous paper [Abs. 1072 (1922)] it was shown that it is possible to calculate the angular velocities of the electrons about the nucleus for the neon atom, which is imagined to have eight electrons at the corners of a cube, the nucleus being at the centre, and the other two electrons being situated within the cube, probably on a line joining the mid-points of any pair of opposite sides. The present paper extends the earlier work and shows how an emission spectrum can be calculated for neon. The wave-lengths of 40 lines have been calculated, and these lie between λ3272 and λ8966.

A. W.

2382. *Free Energy of Gas Molecules.* **M. Planck.** (Preuss. Akad. Wiss. Berlin, Ber. 8. pp. 63–70, 1922.)—According to Gibbs' *addition theorem* both the entropy and the free energy of a gas mixture are obtained by adding their respective values for the constituents of the mixture. Further, the modern statistical basis of thermodynamics warrants the extension of the theorem right up to the limit at which all the molecules become chemically identical, so that the several constituents differ only in the internal energies of their molecules [see Abs. 684 (1921)], which might be due, *e.g.*, to differences in quantum conditions, and might largely or entirely consist in differences of velocity distribution. But, on the quantum theory, the internal energies, like the chemical properties, are discontinuous, while the velocity distribution will, even if discontinuous at low temperatures, at high temperatures become sensibly continuous. The extended validity of the *addition theorem* will therefore mean, apparently, that the time taken by a gas to attain stationary temperature will differ, in general, according to whether the temperature is defined by the internal molecular energy or by the energy of the velocity distribution. And time has no place in the thermodynamic conditions. Then there is the further difficulty of accounting for the so-called *Gibbs' Paradox*, that the interdiffusion of two different gases is distinctly irreversible, even where the gases differ but slightly. For if two gases, whose slight difference consists only in the energy of velocity distribution, are subject to the *addition theorem*, then as they approach identity there will be finite irreversibility right up to these becoming identical, when it will suddenly vanish, so that two states indistinguishable by definition will possess distinct physical properties. These considerations suggest the necessity for a more searching analysis, and the author's starting point is the known expression for the free energy F of a perfect gas, consisting of N similar molecules of molecular weight *m*, with the different discrete energies $\epsilon_1, \epsilon_2, \ldots$ He then calculates the value of F in two ways :—(1) The gas is considered as a mixture of chemically different gases, the constituents containing $N_1, N_2, \ldots$ molecules, to which the *addition theorem* is applied, and hence the values of the N's obtained by making the free energy a minimum. This gives the solution $F = -NkT \log Rs/N$, where $s \equiv \Sigma e^{-\epsilon_i/kT}$, and $R \equiv eV/h^3 . (2\pi mkT)^{3/2}$. (2) The gas is considered as consisting of N molecules, chemically alike, velocity and internal energy being variable, which gives $F = -kT \log \sum_n e^{-E_n/kT}$, where E_n is the energy of the gases in an elementary domain (here assumed infinitesimal) *n* of the phase-space dealt with, and the summation being extended over all domains. The simultaneous development shows that :—(1) If the distinction between two interdiffusing gases vary only discontinuously, *e.g.*, the molecular weight or the quantum state, they cannot become identical by continuous variation. (2) If the distinction vary continuously, *e.g.*, the velocity distribution, the molecules of one kind are not all completely identical, but there exists a finite domain within which they may vary. The mutual approach of two such domains results in partial overlapping, and the decrease of free energy, and with it the irreversibility of diffusion will decrease to zero with practical continuity if the gases become absolutely similar through the operation of any continuous process. The analysis also completely disproves the incompatibility, which some have alleged, between the second law of thermodynamics and the existence of semipermeable membranes. It would arise only in the case pointed out by Maxwell long ago of a one-sided permeability collecting the faster moving molecules on one side and the slower movers on the other.

G. W. DE T.

2383. *General Infinitesimal Geometry, in Reference to the Theory of Relativity.* **W. Wirtinger.** (Cambridge Phil. Soc., Trans. 22. pp. 439–448, May, 1922.)—A generalisation by tensor analysis of Weyl's geometry of parallel displacement. Generalised expressions are obtained for the Riemann-Christoffel curvature tensor and for covariant differentiation. The opinion is expressed that the Kantian view of the intuitive character of space and time can be reconciled with modern ideas. J. S. G. T.

2384. *Review of the Present Status of the Two Forms of Quantum Theory.* **R. C. Tolman.** (Optical Soc. America, J. 6. pp. 211–228, May, 1922. Paper read at Joint Session of the Am. Phys. Soc. and the Am. Assoc. for Adv. of Science.)—The author refers briefly to the deficiency of classical dynamical theory, more especially the conflict between the *apparent* requirements of the Maxwell-Boltzmann distribution law and the actual distribution of energy in a system. Both forms of the quantum theory ascribe a cell-like structure to the generalised $2n$ dimensional space used to represent coordinates and momenta of individual particles in the system. In the first form, points representing molecules or oscillators are located in general only on the boundary surfaces between the cells, while according to the second form, representative points may be located, as in classical dynamics, anywhere in the generalised space. Reference is made to the apparent conflict between the quantum theory and the undulatory theory of light, the arbitrariness of the quantum theory, and the respective achievements of either form of the theory. The author contends that, at present, the abandonment of classical dynamics in favour of the quantum theory must be regarded as tentative, and regards the atomic model furnished by the theory as only partially satisfactory. It is suggested that a ring structure be retained only for hydrogen and singly ionised helium. Alternatively the ring structure may be retained for atoms when dissociated and emitting their spectra, a three-dimensional configuration being employed when the atoms enter into chemical combination. J. S. G. T.

2385. *A General Condition for the Quantisation of the Conditionally Periodic Motions with an Application for the Bohr Atom.* **V. Trkal.** (Cambridge Phil. Soc., Proc. 21. pp. 80–90, May, 1922.)—In a conservative dynamical system of k degrees of freedom, in which the constraints are independent of the time, and in which (the symbols having the customary significance) I_r, ν_r, $\bar{L}$, W may be expressed as functions of structural constants (*e.g.*, matter, charges, field, and kinematical constants characterising the orbit and motion therein), it is shown that the total (classical) energy may be expressed as $W = \sum_{r=1}^{k} \nu_r \int p_r dq_r - \bar{L}$. Its quantisation is effected in accordance with the variation principle $\delta\left\{\sum_{r=1}^{k} n_r h\nu_r - \bar{L}\right\} = 0$. The theory developed is applied to a number of cases, including: a Planck oscillator, rotation about a fixed axis, an electron rotating in a circular, or elliptical, or relativistic circular, or elliptical orbit respectively about a nucleus. The results obtained agree with those previously calculated by other methods. J. S. G. T.

2386. *Study of the Presence or Absence of Nitrogen Bands in the Auroral Spectrum.* **Rayleigh.** (Roy. Soc., Proc. 101. pp. 312–315, July 1, 1922.)—In a previous paper [Abs. 1562 (1922)] it was shown that the negative bands of nitrogen were actually stronger than the green aurora line on the occasion of the auroral display of May 13–14, 1921, which was a typical aurora, in the sense that it was accompanied by conspicuous solar and magnetic disturbance. In contrast with this, the nitrogen bands were not observed at all in the numerous photographs which showed the green line in the night sky on ordinary nights in the south of England [Abs. 824 (1922)]. To get additional evidence numerous photographs have been taken at the meteorological observatory near Lerwick. None of the photographs were equal in intensity to the photograph obtained on May 14, 1921. The Shetland photographs which showed the green aurora line usually showed the nitrogen bands as well, but less strongly than the green line. In this respect the Shetland photographs stand between those of the world-wide aurora of May 13–14, 1921, and the ordinary night sky in the south of England. Further photographs have been obtained of the light given by the night sky at Terling, Essex. For some of these cumulative exposures were employed aggregating up to a total of 180 hours. The green line was found to be given strongly, but there was no trace of the nitrogen bands. With two instruments of greater light-gathering power, working at F/0·9, strong impressions of the green line are sometimes obtained in one clear night, but in no case have the nitrogen bands been detected. A. W.

2387. *An Aerological Survey of the United States.* **W. R. Gregg.** (Monthly Weather Rev. Suppt. No. 20. pp. 1–78, May, 1922. Monthly Weather Rev. 50. pp. 229–241, May, 1922. Abstract of the foregoing.) —This is Part I of the survey, and shows the results of observation by means of kites up to and including 1920. Numerous curves and diagrams are given showing the free-air data. These include seasonal free-air temperatures, mean summer and winter barometric pressures, mean summer and winter wind resultants, and similar data. Curves are given showing the air density and percentage frequencies of winds from different directions. Results are also given in tabular form. W. R. C.

2388. *Riemann's Law, Mercury's Perihelion, and Deflection of Light.* **G. Bertrand.** (Comptes Rendus, 174. pp. 1687–1689, June 26, 1922.)— In order to simplify Riemann's law of electrodynamics, a parameter α is introduced into the equations of motion of a mass m attracted by mass M. Thus f being the attraction coefficient, c velocity of light, and v velocity of m, the equations of motion are written:

$$\frac{d^2x}{dt^2} = -\frac{fMx}{\gamma^3} - \alpha\frac{fM}{c^2}\frac{d}{dt}\left(\frac{1}{\gamma}\frac{dx}{dt}\right) - \frac{\alpha fM}{2c^2}\frac{xv^2}{\gamma^3}$$

and similar ones for y and z.

From these the rotation of perihelion Ω and deflection of light δ become respectively

$$\frac{\delta\alpha\pi^3a^2}{c^2T^2(1-e^2)} \text{ and } (2+\alpha)\frac{fM}{c^2R}$$

(R being the distance of the light ray from the centre of the sun).

By Einstein's formulæ we have

$$d\Omega = \frac{24\pi^3a^2}{c^2T^2(1-e^2)}, \quad \delta = \frac{4fM}{c^2R}$$

while by Newton's law $\alpha = 0$ and we have

$$d\Omega = 0 \quad \delta = \frac{2fM}{c^2R}$$

If we adopt 42″·9 for the secular rotation of Mercury's perihelion we must put $\alpha = 3$ and the deviation becomes $5fM/c^2R$, or 2″·2, instead of Einstein's 1″·75. If, however, we adopt Grossmann's value of 38″, then the α (which characterises the sun's electric field) is approximately 2·6 and $\delta = 2''\cdot 0$.

Therefore to decide between Einstein and Riemann requires measures of extreme accuracy. W. W. B.

2389. *Seventh Report of the Committee for the Investigation of Atmospheric Pollution.* (Meteorolog. Office, Air Ministry M.O. 249 [31 pp.], 1922.)—This report deals with the result of the observations made during the year ending March 31, 1921, and covers 12 cities and towns, in which 31 soot and dust gauges were installed. In addition to the above 31 gauges, automatic apparatus for measuring suspended impurity has been set up at four different centres in London, and also in Glasgow and Rochdale; but as most of these instruments have only been in operation a few months, comparative data for the year are not yet available. Following the lines of previous annual reports the full figures for deposit from all stations are not included, as these are available for reference in the *Lancet* for the 14th and 21st May, 1921. Detailed figures of deposit are given for two stations, representing high and low deposits respectively. As representing low deposits, Rothamsted station has been selected, since the returns here were complete for the year. In previous reports Malvern has been given as representing low deposit, but the returns were not complete at the time of preparation of the report. Another table gives the total solids deposited monthly at all the observation stations. The highest deposits of total solids were shown in Rochdale and Birmingham (Central), the lowest in Rothamsted and Birmingham (South-Western). Birmingham Central heads the list for insoluble carbonaceous and ash, Newcastle being the second highest. The two lowest stations for these elements of pollution were Rothamsted and Southport (Hesketh Park). J. B. C. K.

2390. *The Distances of the Planets from the Sun. Note VI.* **M. Pierucci.** (N. Cimento, 23. pp. 333–342, May–June, 1922.)—In order to study the second cause of error alluded to in Note IV, i.e. the influence (on the formation of each orbit) of the masses of the neighbouring planets and satellites, the author gives a table summing up the results obtained in the five preceding notes and showing the values of the equivalent radii for the planets, the satellites, and the comets of the Saturn class. In the case of the two exterior satellites of Saturn instead of the equivalent radii their projections on the equatorial plane of the planet are given. For the satellites of Uranus the value of the multiplicatory constant is somewhat modified, thus slightly improving the rule. The table shows that the rule applies to 36 bodies of our solar system, which is the greatest number to which any of the hitherto known rules can be applied, and the author believes the general mean error of 3·78 % to be the lowest hitherto attained. The only empirical rule which in some respects may be considered superior to the author's is that of Professor Armellini. Although showing a much larger mean error, it has the great merit of permitting the eight planets to be considered *en bloc* with only one lacuna. The author's rule holds good fairly well in all cases except for the large satellites of Jupiter, in which the mean error is somewhat large (8·78 %), and for the satellites of Saturn VI, VII, and X, for which it does not hold good at all. We have known since Laplace that there is a regularity between the periods of revolution of three large satellites of Jupiter (Io, Europa, and Ganymede). It is now obvious that a similar regularity exists not only for all four Medicean satellites but also for the Vth which revolves near them, in fact, that the periods of revolution of the five interior satellites are as terms of the geometrical progression 1, 2, 4, 8, 16 . . . or, according to Kepler's third law, the semi-great axes of their orbits increase with the exponential rule $a_n = 1{\cdot}587^n$ where $1{\cdot}587$ is $\sqrt[3]{2^2}$, a_n the semi-great axis of the nth orbit, n a whole number. The satellites VI, VII, and X of Saturn have also commensurable periods of revolution. Thus the satellites for which the author's rule is not valid have periods of revolution commensurable among themselves. Further: Hyperion and Themis, which revolve near to Titan with a preponderant mass, have periods which are to that of Titan as 4 to 3. On the other hand, in the case of the four Medicean satellites of Jupiter which have masses comparable to each other the periods show a simple relation, arranging themselves as the numbers 1, 2, 4, 8 without lacunæ, each satellite having a period double its nearest interior and half its nearest exterior neighbour.

Now we may imagine that something, if not similar, at least analogous to what happens when together with a fundamental note we strike its octaves occurs in the oscillatory motions of the celestial bodies, i.e. that the reciprocal perturbations, added together in the course of centuries, tend to a simplification of the relations of the periods of revolution. A discussion of Armellini's exponential rule suggests the hypothesis that the deviations from the author's rule are due to this tendency. Finally the author arrives incidentally at a confirmation of the non-stellar hypothesis of comets. Many arguments have been accumulated by astronomers in recent years which render extremely probable the solar origin of comets. His own results may be thus summarised: (1) Twenty of the comets whose period is known have equivalent radii ρ_m contained within those of the asteroids; the other five have radii approximate to that of Saturn. (2) A minor planet-comet has been discovered whose ρ_m the author has shown to be contained between the ρ_m of Mars and Jupiter. (3) The five comets whose ρ_m are approximate to the ρ_m of Saturn have radii multiples of the same length of which the ρ_m of the interior planets are multiples. E. F.

2391. *Method of Deriving the Distance of A-type Stars.* **W. S. Adams** and **A. H. Joy.** (Nat. Acad. Sci., Proc. 8. pp. 173–176, July, 1922.)—Trigonometrical parallaxes are only of special value when the parallax is large compared with the probable error. Hypothetical parallaxes derived from binary systems are affected by the uncertainty of the mass-factor. Parallaxes of greater mean accuracy are derived from group motion. To supplement these the authors have sought for a possible correlation between absolute magnitude and the intensity of certain spectral lines similar to that successfully used for later type stars. 100 stars, with distances and absolute magnitudes determined by the methods first mentioned, formed the basis of the investigation and were classified according to the Harvard scale A_0, A_1, A_2, etc., the suffixes n and s denoting that the lines were nebulous or sharp. This distinction is not marked at A5 or later. A few stars of the c class, of which α Cygni is a prominent example, have exceptionally sharp and narrow lines, especially enhanced lines. In most of these the Sr + lines at λ4077 and λ4215 are very intense. The absolute magnitudes M are tabulated according to type and show a steady increase in M with advancing type and a marked difference between n and s in each class. Reducing by the correlation curve to type A7 the table shows a great accordance, the total range being from $2{\cdot}0$ to $2{\cdot}6$.

The result of the comparison shows that the table will furnish absolute magnitude and parallax for A stars with precision as great as that

of the other methods, with the exception of the *c* stars. A few examples are given showing the parallax computed by this method and that actually observed.

	Type.	Computed.	Observed.
α Lyræ	A1s	0·09	0·10
ζ Ursæ Maj.	A2s	0·044	0·045
Taurus group (26 stars)	A0–F	0·024	0·023
Præsepe (4 stars)	A2–A6	0·011	0·011

The spectra of the fainter stars has been found to be diffused as compared with those of brighter stars, as also appears from the present investigation. Great intrinsic brightness is associated with sharp and narrow lines, and this is probably due to the low density of the atmospheres. This is marked in stars of various types such as Rigel, α Cygni, the Cepheid variables and Betelgeuse, and is well illustrated by Mira Ceti as it varies from maximum to minimum. W. W. B.

2392. *Continuous Radiation Found in some Celestial Spectra beyond the Limit of the Balmer Series of Hydrogen.* **W. H. Wright.** (Nature, 109. pp. 810–812, June 24, 1922.)—The outlying continuous spectrum found in certain celestial spectra such as the emission spectrum of the solar chromosphere and the absorption spectra of α Cygni and Vega, appears from the discussion here given to be due to hydrogen. The spectrum can be explained, on the basis of Bohr's theory, as resulting from a change of state, as between a free electron and one in the second orbit. A theoretical treatment shows the beginning of the outlying spectrum to be situated not at the theoretical limit of the Balmer series, but further towards the red, the amount of displacement being greater as the number of observed lines is less. Observation of the three spectra mentioned above is in approximate agreement with this conclusion. [See Abs. 497 (1918).] A. W.

2393. *Oscillations of Spectral Lines of Double Stars Explained by New Law of Projection of Energy of Light.* **G. Sagnac.** (Comptes Rendus, 175. pp. 89–91, July 10, 1922.)—As an illustration of his new idea [see Abs. 1266 (1922)], the author considers the case of Y Sagittarii, a Cepheid variable with a period of 5·77 days, in which the want of symmetry of the light curve is marked. The suggested energy shift is supposed to act in each revolution, so that in the 136 years taken by the light from the star to reach us, the small change has a large factor $\frac{136 \times 365}{5\cdot 77}$. The author deduces a value 1·03 for the shift and 0·47 for the displacement of the centre of gravity of the light curve, which he claims is in close agreement with 0·477 from spectroscopic observations. He distinguishes between the two separate effects, the Fizeau effect, which is a geometrical shift of the light rays, and the energy shift, which involves an acceleration or retardation of the velocity of the rays. W. W. B.

LIGHT.

2394. *Opalescence Phenomena in Liquid Mixtures.* **C. V. Raman.** (Nature, 110. pp. 77–78, July 15, 1922.)—Liquids which mix completely above a certain critical temperature, *e.g.*, phenol and water, exhibit a strong and characteristic opalescence as the temperature of the mixture is lowered to a point slightly above that at which the components separate. It is here shown that Einstein's expression for the light-scattering power requires certain correction terms. The result of these corrections is that very near the critical temperature the fluctuations of concentration contribute by far the larger portion of the effect. But at higher and at lower temperatures the effects of fluctuations of density and molecular anisotropy are no longer negligible, and when the temperature is sufficiently removed from the critical point they form a substantial part of the whole. Further, the increase in relative importance of the effect of molecular anisotropy in these circumstances should result in an increase in the proportion of unpolarised light in the transversely-scattered beam as we leave the critical temperature. The foregoing theoretical predictions have been generally confirmed in a series of experiments over a wide range of temperatures on light scattering in phenol-water mixtures carried out by V. S. Tamma. A. W.

2395. *Theory of the Measurement of Visibility.* **A. Wigand.** (Phys. Zeits. 23. pp. 277–288, July 15, 1922.)—An instrument for the measurement of the opacity of the atmosphere has been dealt with in several previous papers [see Abs. 1000 (1919) and Abs. 293 (1922)]. It is found that the opacity (per unit thickness) so measured is not independent of the distance of the object used in the determination, on account of a difference between the laws according to which the opacity of the atmosphere and of the ground-glass screens in the instrument varies with the thickness of the layer and with the number of superimposed screens respectively. This is investigated experimentally and a correction made to the formula employed in evaluating the opacity from the instrumental readings. The paper also contains results showing the dependence of visibility on the direction of the object relative to the sun. M. A. G.

2396. *The Firefly as an Illuminant.* **H. E. Ives.** (Frank. Inst., J. 194. pp. 213–230, Aug., 1922.)—This investigation relates to the intensity and the nature of light yielded by the firefly. Measurements of brightness were made by holding the firefly in front of a surface, the illumination of which could be adjusted until there was apparent equality of brightness. By this method the brightness of the firefly was found to be about 0·0144 lumen per sq. cm. This may seem low as compared with the average brightness of the sky (1·0 lumen per sq. cm.), and especially with that of typical artificial sources of light. But it is not too low to be of practical value if we could produce synthetically extensive surfaces giving a steady brightness of this value. The radiation of the firefly is too weak to be measured by physical methods. But by indirect reasoning it is inferred that the radiant luminous efficiency may be of the order of 80 %. The luminous efficiency is conjectured to be about 580 lumens per watt. In order to study the distribution of energy in the spectrum two methods (*a*) involving photography with panchromatic plates (*b*) based on the extinction of phosphorescence were used. It is established that all the recognisable radiation is located within the visible spectrum and consists mainly of a narrow band between 0·5 and 0·6 μ, where the visual sensitiveness to light is most pronounced.

J. S. D.

2397. *The Position of Best Focus in the Presence of Spherical Aberration.* **T. Smith.** (Phys. Soc., Proc. 34. pp. 145–149; Disc., 149–150, June, 1922.)—Focal variations of phase in the presence of spherical aberration are calculated directly from the axial intersection points of rays of known inclination, and the graphical method employed shows that the focus for which phase variations have a minimum value may be found and suitably interpreted when the finiteness of the wave-length is disregarded. The diagrams employed for the representation of spherical aberration have advantages over the more usual diagrams in several important particulars, and it is suggested that the older forms should be abandoned. AUTHOR.

2398. *The Determination of Poisson's Ratio and of the Absolute Stress-Variation of Refractive Index.* **F. Twyman** and **J. W. Perry.** (Phys. Soc., Proc. 34. pp. 151–154, June, 1922.)—The paper describes a ready method of determining the stress-optical coefficients, the Hilger interferometer being employed. Young's modulus of elasticity and Poisson's ratio are determinable simultaneously. AUTHORS.

2399. *Carbon Dioxide Absorption in the Near Infra-Red.* **E. F. Barker.** (Astrophys. J. 55. pp. 391–398, June, 1922.)—New absorption curves have been obtained, using a special prism-grating double spectrometer of high resolution. The 2·7 μ region, heretofore considered to be a doublet, proves to be a pair of doublets, with centres at approximately 2·694 μ and 2·767 μ. The 4·3 μ band appears as a single doublet with centre at 4·253 μ. The frequency difference between maxima is nearly the same for each of the three doublets, and equal to $4·5 \times 10^{11}$. Complete resolution of the band series was not effected, even though the slit included only 12 A for the 2·7 μ region, but there is evidently a complicated structure, with a " head " in each case on the side of shorter wave-lengths.

Molecular Structure of CO_2.—If a linear configuration of the three atoms is assumed, the moment of inertia of the molecule, computed from the doublet frequency difference, becomes 50×10^{-40}. This gives the distance from the central C atom to each O atom as $0·97 \times 10^{-8}$ cm. Since the linear molecule could have only three modes of vibration, it is suggested that the two doublets at 2·7 μ may correspond to two successive changes in stationary state for the same vibration. W. R. C.

2400. *Thickness of Air Required to Produce the Atmospheric Absorption Bands, A, a, and B*[1]. **A. S. King.** (Mt. Wilson Observat. Contrib. No. 232. Astrophys. J. 55. pp. 411–412, June, 1922.)—On a plate stained with dicyanin, the A and B bands were obtained when the light from a tungsten lamp traversed minimum thicknesses of only 7 and 40 metres respectively; and though the air was hot and dry, the water band *a* at λ7200 was obtained with absorption of 9·5 metres. To give the bands A and B visually, respectively twelve and five times greater thicknesses of air are required. AUTHOR.

2401. *A Simple Method of Measuring Absorption in the Ultra-Violet.* **C. Winther, Baggesgaard-Rasmussen and E. Schreiner.** (Zeits. wiss. Phot. 22. pp. 33-46, Aug., 1922.)—Merton's method is adopted, and a solution of *p*-nitrosodimethylanilin is used as absorption layer. A full description of the apparatus used is given and is illustrated by diagram and photographs. The fluorometric method is examined and measurements obtained with a new fluorometer are given. A comparison is also made between the fluorometric and photographic methods. The improved fluorometer was constructed for extinction measurements of single wave-lengths. The usefulness of the instruments was controlled by thermo-electric measurements. The quantitative photographic method was used for experiments with potassium nitrate and silver nitrate, and it is found that the positions of maximum absorption can be much more accurately placed by this method than by the qualitative method.

A. E. G.

2402. *Molecular Æolotropy in Liquids.* **C. V. Raman.** (Nature, 110, p. 11, July 1, 1922.)—A remarkable feature shown by many liquids in experiments on the molecular scattering of light is that the scattered beam in a direction transverse to the primary rays shows a large admixture of *unpolarised* light, the proportion of this to polarised light in the scattered beam being several times greater than in the case of the same substance in the condition of vapour at atmospheric pressure. The polarised and unpolarised parts of molecularly scattered light may be conceived as arising in two distinct ways; the former is a *mass-effect* arising from the thermal fluctuations of density in the fluid, and its magnitude is given by the Einstein-Smoluchowski formula, and as we pass from the condition of vapour to that of liquid in which the molecules are more closely packed together, it increases much less than in proportion to the density. The *unpolarised* part of the scattered light is, on the other hand, a *molecular* effect, and its magnitude increases simply in proportion to the number of molecules per unit volume. The ratio of the unpolarised to the polarised part of the scattered light should therefore be considerably enhanced in the case of a liquid. This is exactly what is observed, good agreement being obtained between the theoretical ratios and values experimentally determined by K. S. Rao. The Einstein-Smoluchowski formula indicates that though the density of a liquid diminishes with rise of temperature, its scattering power should increase and become very large as the critical temperature is approached. Similarly, as the temperature is increased, the scattering power of the saturated vapour should increase much more rapidly than in proportion to its density. Accordingly, in both cases, we should expect the polarisation of the scattered light to improve steadily with rise of temperature and become practically complete as the critical temperature of the liquid is approached. Experiments with benzene liquid and vapour by K. R. Ramanathan have quantitatively confirmed this prediction. A similar improvement in polarisation has also been observed by V. S. Tamma in experiments on the scattering of light in binary liquid mixtures as the critical temperature for separation into two phases is approached.

A. W.

2403. *Optical Constants of Selenium in the Form of Isolated Crystals.* **L. P. Sieg.** (Optical Soc. America, J. 6. pp. 448-460, July, 1922.)—Further measurements have been made of the principal reflecting powers of a crystal of selenium [Skinner, Abs. 920 (1917); Weld, Abs. 1268 (1922)]. The results show the existence of double reflecting powers, which lie on either side of, although they are not equidistant from, the single values previously obtained with a polished plate of selenium. The experimental data agree rather better with Skinner's than with Weld's results, but the values calculated from the latter are possibly the more accurate. T. H. P.

2404. *Temperature Coefficient of Magnetic Double Refraction.* **G. Szivessy.** (Ann. d. Physik, 68. 2. pp. 127–153, July 20, 1922.)—The temperature coefficient of magnetic double refraction was experimentally investigated for five different liquids (nitrobenzol, chlorobenzol, bromobenzol, pseudocumol, and α-bromonaphthaline). The formula $C = \text{const.} \times \delta(n^2 + 2)^2/nT$ calculated from the Langevin molecular orientation theory for a particular wave-length, was not found to be in agreement with the observations. In the above formula C is the Cotton-Mouton constant [Abs. 1503 (1907) and 233 (1908)], δ the density, *n* the refractive index, and T the absolute temperature of the liquid. The value of C was found to increase much more rapidly with decrease of temperature than would be expected from the theory. The discrepancies were greatest for nitrobenzol, and least for α-bromonaphthaline. [See Abs. 840 (1922).] A. W.

2405. *Chemical Actinometers.* **A. Benrath, E. Hess, and A. Obladen.** (Zeits. wiss. Phot. 22. pp. 47–64, Aug., 1922.)—*Photochemical Action of Sunlight.*—In the present paper three kinds of actinometer are dealt with, the mercury chloride-ammonium oxalate actinometer, the oxalic acid actinometer, and the iron chloride actinometer. These three instruments are compared at some length, and tables are given showing the action of sunlight on these under certain specified conditions. The action of tartaric and lactic acids as reducing agents, and the action of the latter when supplemented by certain sulphates, in particular, ferri-ammonium sulphate is also considered. It is found in these experiments on the photochemical action of climate that a Sebelien actinometer containing Eder's solution as reaction fluid is suitable only within narrow limits, the easily managed iron chloride and oxalic acid-uranium salt actinometers have a wider range of usefulness. Reasons are given for the assumption that only the ferri-ion and the oxalat-ion are photochemically active, the undissociated portions contributing nothing to the reaction. A. E. G.

2406. *Electric Furnace Experiments Involving Ionisation Phenomena.* **A. S. King.** (Mt. Wilson Observat. Contrib. No. 233. Astrophys. J. 55. pp. 380–390, June, 1922.)—*Furnace Temperature Required to Obtain the Subordinate Series Lines of the Alkali Metals in Absorption.*—With the central plug at about 2600° C., the stronger lines of both the first and second subordinate series of K, Cs, and Rb were readily obtained, while for Na, less than 2350° was required. The lines observed for each metal are listed. The temperature of the absorbing vapour may be taken as about 400° less than that of the plug.

Furnace Absorption Spectrum of Iron Vapour above 2800° C.—Using lower temperatures, no absorption lines had previously been obtained longer than λ5507, but with a plug temperature above 3200°, practically all the high temperature emission lines were obtained in absorption, up to the end of the range photographed, $\lambda 6700$.

Furnace Spectra of Ca, Sr, and Ba Vapours Mixed with more easily Ionised Elements, K and Cs.—Flame lines are not affected, but the intensity of enhanced lines was found to be decreased for both absorption and emission spectra, when the easily ionized vapour of K (4·3 volts) or of Cs (3·8 volts) was added, the effect being very marked for Ca (6·1 volts), somewhat less for Sr (reduction to one-third) and small for Ba (5·2 volts), while adding Na (5·2 volts) to Ba vapour produced no change. Evidently the quenching effect depends upon the relative ease of ionization of the two vapours. Temperatures of 1800–1830° were used.

Furnace Temperatures Required to Obtain Certain Flame Lines in Absorption and in Emission.—The lines $\lambda 4227$ (calcium), $\lambda 4607$ (strontium), and $\lambda 5535$ (barium) were obtained in absorption (tungsten lamp source) but not in emission (exposure 2 hours) at temperatures of 1275°, 1200°, and 1400° C. respectively. This lag of emission over absorption may be partly due to the wideness of the lines, and is not noticeable for sharp iron lines.

Relation of Furnace Observations to Saha's Theory of Spectra.—The foregoing results verify Saha's predictions that the subordinate series of the alkalies could be obtained in absorption if sufficiently hot vapour were used, and that a gas too cool to emit light should still be able to absorb the lines of the principal series; and the results with mixed gases are such as would be expected if flame and enhanced lines are associated with neutral and ionised atoms respectively, as Saha assumes.

AUTHOR.

2407. *The Broadening of the Balmer Lines of Hydrogen with Pressure.* **E. O. Hulburt.** (Astrophys. J. 55. pp. 399–405, June, 1922.)—There is some question as to whether among the possible causes of the widening of lines with pressure, the decrease of mean free path is important. A theoretical calculation of the width to be expected for hydrogen lines if the length of the train of waves emitted is limited by the time between molecular collisions, gives for a temperature of 600° C. and a pressure of 100 mm. a width of about 0·04 A, between wave-lengths where the intensity is one-tenth of that at the middle. Experimentally, however, it was found that a pressure of about 100 mm. gave photographic images 80 A wide. Purified hydrogen in a capillary discharge tube was excited by condensed discharges and a series of spectrograms were taken for pressures from 0·2 to 135 mm. The exposure time was 30 minutes in each case and the discharge was regulated so that the intensity of the central portion of $H\beta$ was practically the same for all pressures. It is shown that $H\beta$, $H\gamma$, and $H\delta$ behave very much alike. The fact that the actual width is much greater than that computed theoretically indicates that the widening of spectrum lines is probably due to some other cause, perhaps electrical fields.

AUTHOR.

2408. *Difference between Series Spectra of Isotopes.* **J. W. Nicholson.** (Nature, 110. p. 37, July 8, 1922.)—Ehrenfest and Bohr have previously raised the question of the difference to be expected between the spectra of isotopes [Abs. 2288 (1922)]. The present paper gives a further consideration of the subject. McLennan [see next Abstract] found a difference which is three times greater than that calculated by the Bohr formula. The quantum theory is unable to explain this large separation, and its exponents must doubt the fact that McLennan's new series is the spectrum of an isotope. There are two alternatives—it may be a combination series or a spark series. In an investigation (not yet published) made by the present author on some of the simpler possible orbits in a lithium atom with only two electrons, a specially simple class of orbits was found, and this arrangement gave, as the principal spark-line of lithium, a value very close to λ6708. In these simple orbits of a lithium atom positively charged, the two electrons are behaving very differently. The orbit of one of them is only about 1/10 the linear dimensions of the other, so that the Bohr formula for one electron is nearly applicable. In fact, the orbits are very closely analogous to those now generally accepted for the neutral helium atom, which can take two forms, in both of which the orbit of one electron is very small compared with that of the other. By a choice of the simpler orbits, and by the supposition made by Sommerfeld and others as to the invariability of the energy W for all possible orbits, it has been found possible to show that the inner orbit has a radius of only about 1/10 of that of the outer. Thus the Bohr formula is again nearly true, and the Rydberg constant in the ordinary helium series is not very different from its value in the Pickering series. Such results appear to indicate that when there are many electrons in an atom, a ratio of order 1/10 exists between the orbital radii of the two outer consecutive electrons. An immediate consequence is that the Bohr formula would never be very far wrong in its use for a rough determination of the separation to be looked for in the spectra of isotopes.

A. W.

2409. *Structure of the Line λ6708 of the Isotopes of Lithium.* **J. C. McLennan** and **D. S. Ainslie.** (Roy. Soc., Proc. 101. pp. 342–348, July 1, 1922.)—The character of the red Li line λ6708 has been studied by Takamine and Yamada [Abs. 1836 (1914)], Kent [Abs. 1256 (1914)], and by King [Abs. 105 (1917)]. A recent study of the structure of this line was made by the present authors, using a vacuum arc in lithium vapour as a source of radiation, and using both Lummer plates and a 30-plate échelon grating crossed with a Lummer plate to effect the resolution. It was found that when strong arcs were maintained in the vapour, the red lithium line consisted of a close quartet with separations of 0·128 Å., 0·173 Å., and 0·165 Å. A detailed description is given of the apparatus employed and of the results obtained, typical photographs being reproduced. In the recent discussion on isotopes at the Royal Society [Abs. 1678 (1921)] Merton stated that if lithium is accepted as a mixture of two isotopes of atomic weight 6 and 7, calculations based on Bohr's theory showed that each of the components of the λ6708 doublet should be accompanied by a satellite about 16 times as faint and displaced by 0·087 Å. The discovery of a new doublet accompanying the ordinary doublet of λ6708 opens up the question of its origin being associated with the isotope of lithium. This question is discussed at some length from consideration of (1) the similar magnetic resolutions obtained in weak fields for the sodium D lines and the lithium red line, (2) the displacement of isotope doublets, (3) isotope displacement and atomic number, (4) intensity of doublet components, and (5) identity of components.

Observations on other Wave-Lengths.—A cursory examination was made of the structure of other lithium lines, and it was found that the line λ6103·77 consists of at least three well-defined components. The line λ4602·37 was also seen to be resolved, but accurate visual observations with this line were difficult. Detailed results of measurements made on these lines will be given later. A. W.

2410. *Spectrum of Beryllium: Connection with Aluminium Spectrum.* **L. C. Glaser.** (Ann. d. Physik, 68. 2. pp. 73–88, July 20, 1922.)—Measurements have been made of the wave-lengths of 12 lines observed in the spectrum of a pure sample of metallic beryllium prepared by A. Stock. The majority of the lines, whose wave-lengths extend from λ3891 to λ4607, are new. A comparison of the series of beryllium and aluminium bands shows a remarkable similarity in the series groups and in the first differences of wave-lengths or of frequency. A. W.

2411. *Series and Other Regularities in the Spectrum of Manganese.* **M. A. Catalán.** (Roy. Soc., Phil. Trans. 223. pp. 127–173, July 20, 1922.)—The author summarises as follows: The flame, arc, and spark, spectra of manganese, like those of other elements, are formed of two classes of lines, some belonging to the neutral atom and some to the ionised atom (Mn^+). In the spectrum of the neutral atom, triplet series and combination lines have been found. The series follow a Hicks formula with a Rydberg constant N, and may be classified as follows:—

(*a*) A system of four triplet series (sharp, diffuse, principal, and fundamental; the last two being rather doubtful), analogous to the ordinary triplet systems of series in the alkaline earths.

(*b*) A system of three narrower triplet series (sharp, diffuse, and principal) which have strong analogies with the singlet systems of series in the alkaline earths.

(*c*) Another system of yet narrower triplets (sharp, diffuse, and principal) which is parallel to the preceding system, the shift number being $C = 10967 \cdot 75$.

The intercombination lines $1S - 1p_2$ and $1S - 1p_3$ (λ5394·677 and λ5432·555) between the first two systems are found as two lines very prominent at low temperatures and losing very much of their intensity at high temperatures. The ionisation and resonance potentials of manganese have been calculated from the term 1S and from the wave-number of the line $1S - p_2$. The values are 7·4 volts and 2·3 volts respectively. The lines of ionised manganese (enhanced lines) also form triplets. The observations are not yet sufficiently complete to permit the series to be traced, but there is evidence that they include a system of triplets, and also another series of narrower triplets, corresponding to the singlet systems in the alkaline-earths, as in the case of the neutral atom. Each diffuse triplet, in neutral and ionised atom alike, is formed of nine lines, giving five "*d*"-terms in contrast with the *six* lines giving three "*d*"-terms which are found in the more familiar diffuse triplets of the alkaline earths.

In the spectra of both the neutral and ionised atoms there are certain groups of prominent lines having the same character and showing similar variations with changes of temperature. The lines of each group are related by very exact numerical separations, and it is suggested that the word "multiplet" be used to denote them. It is pointed out that similar multiplets exist in the spectra of Mg, Cr, Sr, Ba, Al^+, Sc^+, Y^+, La^+, Si, and Cr, and that they may represent a form of regularity present in the spectra of many elements, and serve to indicate the most probable nature of the series in the spectra where the actual series have not been traced.

The spectrum of manganese in relation to the place of the element in the periodic table is discussed. It seems probable that the neutral atom of manganese has *two* electrons in the outermost ring, and that when this atom loses an electron, thus becoming ionised, another electron, from the next ring, comes out to take its place in the outermost ring, which again contains two electrons. The similarity of the spectra of the neutral and ionised atoms may thus be accounted for. A. B. W.

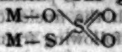
2412. *Spectral Energy Distribution and Opacity of Wire Explosion Vapours.* **J. A. Anderson.** (Nat. Acad. Sci., Proc. 8. pp. 231–232, July, 1922.)—When the discharge from a large high-voltage condenser is passed through a fine wire, the wire vaporises so rapidly that the phenomenon is best described as an explosion. If the explosion takes place between two blocks of wood, 2 or 3 mm. apart, the lines of the metal exploded appear as absorption lines in a continuous spectrum. A preliminary study of the spectral energy distribution given by the explosion of iron wires has been made, using a quartz spectrograph vacuum thermocouple and galvanometer. The value of $E\lambda d\lambda$ increases very rapidly from the infra-red to about $\lambda 4300$; from this point to the ultra-violet the values of $E\lambda d\lambda$ oscillate considerably, but tend upwards, the highest values being reached between $\lambda 2600$ and $\lambda 2150$. Spectrograms of the explosions of the following metals have been made, using a grating spectrograph: Cu, Ag, Au, Mg, Zn, Cd, Al, Sn, Pb, W, Fe, and Ni. All give a continuous spectrum with characteristic absorption lines.

Further experiments showed that the light from a spark between brass terminals could not pass through the vapours (4 mm. thick) generated by the explosion of an iron wire. Other experiments make it probable that a layer about 2 mm. thick is very nearly opaque, so that the absorption coefficient must be very large. A. W.

2413. *Intensity of X-Ray Reflection.* **W. L. Bragg** and **R. W. James.** (Nature, 110. p. 148, July 29, 1922.)—A note replying to a paper by A. H. Compton and N. L. Freeman on "Intensity of X-ray Reflection from Powdered Crystals," in which these authors find a discrepancy in the case of reflection by the (100) planes of rock salt, between their figures and those of the present writers. The discrepancy is now shown to be smaller than was previously supposed. A. B. W.

2414. *Absorption Spectra of Sulphur for X-Rays.* **A. Lindh.** (Comptes Rendus, 175. pp. 25–27, July 3, 1922.)—Reference is made to previous experiments on the absorption spectra of chlorine [Abs. 1439 (1921)] in which the K limit was found to differ with the valency. The author has found an analogous effect for sulphur in its allotropic modifications and when combined with different valency. For the research a spectrometer due to Siegbahn was used. The combinations examined were:

Divalent sulphur in Na_2S, CaS, CuS, Ag_2S, CdS, HgS.
Tetravalent „ in Na_2SO_3, $CaSO_3$, $CuSO_3$.
Hexavalent „ in the sulphates of Li, Na, K, Rb, Ca, Cu, Ba, Ag, Hg.
Di and hexavalent sulphur in $Na_2S_2O_3$, $K_2S_2O_3$.

As for chlorine, with rise of valency, the K limit was displaced towards the smaller frequency limit of the spectrum, and the difference between di- and tetra-valent sulphur equalled 1 mm. of the plate which corresponds to a difference of wave-length of 14 × and 22 × units, or calculated from Einstein's equation [? Planck's equation, Abstractor] this is a difference of 7 and 11 volts. Tetravalent sulphur gives a double limit, the lower of which corresponds to that of hexavalent sulphur, and rhombic sulphur corresponds to divalent. The general view of the constitution of thiosulphates namely  is confirmed by the author's results. **B. J. L.**

2415. *Resolution of the Kα-Doublet in the Powder Method of X-Ray Crystal Analysis.* **L. W. McKeehan.** (Frank. Inst., J. 194. pp. 87–92, July, 1922.)—The author summarises as follows:—Double spots due to reflection of two nearly equal wave-lengths by the same crystal may be of two kinds: (1) Fine parallel lines are due to reflection of rays from different parts of the source by a very small crystal. The separation of such lines depends only upon the difference in wave-length, the mean wave-length, and the mean of the observed angles of reflection. They are excellent objects under the microscope and give an accurate method for determining small differences in wave-lengths. (2) Projected images of the whole source are due to reflection of rays from each point of the source at different points in the crystal. The separation of such images depends upon the difference in wave-length, the mean wave-length, the mean of the observed angles of reflection, and upon the ratio of the whole path-length of the rays to the path-length after reflection. In the usual arrangement spots of the second kind are about twice as far apart as spots of the first kind.

Duane's value for the wave-length difference of the Kα-doublet of molybdenum has been checked by measurements on spots of the first kind. **A. B. W.**

2416. *X-Ray Doublets and Sharpness of Spectral Lines.* **A. Sommerfeld** and **W. Heisenberg.** (Zeits. f. Physik, 10. 6. pp. 393–398, 1922.)—Theoretical observations based on Bohr's classical theory of radiation resistance and the correspondence principal as applied to radiation. **A. B. W.**

2417. *Number of Electrons Liberated by Very Soft X-Rays.* **J. Herweg** and **G. Mie.** (Ann. d. Physik, 68. 2. pp. 120–126, July 20, 1922.)—As a result of their observations the authors conclude that the number of electrons liberated from a metal layer radiated by X-rays is strictly proportional to the intensity of the X-rays, provided the intensity is very small and that the number of electrons emitted per sq. cm. per minute is also small. **A. B. W.**

RADIO-ACTIVITY.

2418. *Distribution of Radio-Active Substances in Solutions.* **H. Lachs** and **M[athilde] Wertenstein.** (Phys. Zeits. 23. pp. 318–322, Aug. 15, 1922.)—The authors show that solutions of Po, RaE, RaD, and Ra under known conditions are not uniform, in the sense that the distribution of radio-activity in different layers is different, increasing with the depth of the observed layer. A. B. W.

2419. *Scattering of β-Particles.* **B. F. J. Schonland.** (Roy. Soc., Proc. 101. pp. 299–311, July 1, 1922.)—The experiments described, together with those of Crowther and the author [see Abs. 1320 (1922)] lead the author to the following conclusions:

(1) The scattering of β-particles observed is a single phenomenon, due to collisions with the nuclei of the atoms encountered.

(2) The relations following from Rutherford's theory of single scattering are in general obeyed, though a correction due to the increase of mass with velocity is necessary in the case of the β-particle.

(3) Evidence for this correction has been found in the variation of scattering with velocity.

(4) The anomalous behaviour of the heavier elements described in the previous paper has been traced, and an explanation based upon the screening action of the electrons surrounding the nucleus appears to be satisfactory.

(5) The sources of error in the form of apparatus used have been examined, and absolute numerical values for the scattering found which are in satisfactory agreement with the theory. It may be added that (4) offers direct evidence for the approximate position and distribution of the electrons surrounding the nucleus. From (3) and (5) it is concluded that the law of force in these collisions is that of the inverse square from 10^{-11} or 10^{-10} cm. of the nucleus of the atom. A. B. W.

2420. *Straggling of α-Particles by Matter.* **G. H. Henderson.** (Phil. Mag. 44. pp. 42–52, July, 1922.)—The author shows that the straggling of α-particles, as deduced from both ionisation and counting experiments, is several times greater than that deduced from theory based on present-day views of the mechanism involved in the passage of α-particles through matter. In a previous paper it has been shown that the effect of the calculated straggling can be adequately accounted for by the tailing off of the ionisation curve at the extreme end of the range. The large additional straggling observed behaves quite differently. Evidence is given in the present paper to show that it increases very slowly with increase of molecular stopping power, and furthermore, that it all takes place within the last few millimetres of the range. Similar conclusions have been reached by Shimizu [Abs. 148 (1922)] from Wilson tracks, observing that the experimental number of α-ray tracks which fork at the end of the range is much greater than the number deduced from probability considerations based on present theories of atomic structure.

It is important to note that this anomalous behaviour of the α-particle occurs at low velocities, where practically no investigation of the scattering of α-particles has been carried out on account of the experimental difficulties of dealing with slow α-particles. It is at higher velocities, where the theory of scattering put forward by Sir Ernest Rutherford has been so fully verified by experiment, that most of the theoretical straggling takes place, and this straggling has apparently been accounted for. A. B. W.

HEAT.

2421. *Thermal Expansion of a Few Steels.* **W. Souder and P. Hidnert.** (Bureau of Standards, Bull. 17. pp. 611–626 [Sci. Papers, No. 433], 1922.)—Thermal expansion data are given for 28 specimens of iron and steel, most of which were heated above 900° C. The expansion of iron was determined over the range 25° to 945° C. The expansion from 25° to 100° C. was found to be $12{\cdot}0 \times 10^{-6}$. The average expansion of a number of steels, over this same range, was found to be $11{\cdot}2 \times 10^{-6}$, and for the range 25° to 600° C., $14{\cdot}2 \times 10^{-6}$. The coefficient for the ordinary steels was approximately 23×10^{-6}. The shrinkages and warpages are interpreted in terms of the rate of expansion and the rate of temperature reduction on passing through the critical regions. W. R. C.

2422. *Investigations on Specific Heat at Low Temperatures.* **F. Simon.** (Ann. d. Physik, 68. 3. pp. 241–280, Aug. 3, 1922.)—This paper is a continuation of previous work of Nernst and his collaborators [see Abs. 1702 (1911)]. The substance to be examined is suspended by a thread in a good vacuum and is heated by the supply of a definite quantity of electrical energy and the rise in temperature is measured. The paper gives the improvements in construction of the apparatus in order to obtain the highest accuracy and to economise the quantity of liquid hydrogen required. A diagram of the essential parts of the calorimeter, with thickness and dimensions of material used, is given. The arrangement of apparatus finally used is an improvement on that described in Abs. 1084 (1914).

The materials examined were Lindemannglas christobalit (SiO_2), quartzglass (SiO_2), mercury, ammonium chloride, cuprous iodide, grape sugar, ketonharz (an artificial resin), and glycerin. A discussion of results obtained is given, and a comparison of calculated data with experimental results, based chiefly on the employment of Debye's and Einstein's functions and Nernst's T^3 law for atomic heat. Some noteworthy results are obtained, among which may be mentioned: (1) The enormous increase in sp. heat of NH_4Cl at 242° to 243° abs., and an equally sudden decrease before 244·5° abs. is reached. This is probably accounted for by a change of state in the NH_4 radical, the whole radical vibrating as one atom before the increase. (2) The atomic heats of organic compounds are small, and the graphs connecting sp. heat and temperature are straight lines above 70° abs. and all have the same inclination to the axis. A general rule for the energy relations of these compounds is obtained. (3) The sp. heat of undercooled glycerin shows a very great change which is connected with the softening of the compound. (4) The free energy of cuprous iodide is calculated and found to agree with the experimental results. The bearing of the results on the structure and changes of structure in molecules at low temperatures is discussed. T. B.

2423. *Evaporation of a Liquid into a Gas.* **W. K. Lewis.** (Am. Soc. Mech. Eng., J. 44. pp. 445–446, July, 1922.)—A formula is established for calculating the humidity of air from wet- and dry-bulb thermometer readings. It is then shown that if s is the "humid heat," or number of heat-units necessary to change the temperature of unit weight of vapour-free gas, plus the vapour it contains, one degree; h is the surface coefficient of conductivity of heat between gas and liquid, or B.Th.U per unit time per unit surface area per unit temperature difference; and k is the coefficient of diffusion, or parts by weight of vapour diffused per unit time per unit area per unit vapour-pressure difference; then $s = h/k$. This ratio h/k can be calculated from the observed wet- and dry-bulb temperatures for any vapour gas mixture of a known gas humidity, and the equation $s = h/k$ is shown experimentally to be true for water-air, water-CO_2, toluol-air, and chlorbenzol-air. These processes of diffusion of heat and of vapour are at the basis of the performance of all such equipment as humidifiers, dehumidifiers, water coolers, gas scrubbers, air driers, light oil stripping columns, and the like. T. B.

2424. *Vapour Densities at Low Pressures and Over an Extended Temperature Range.* I. *Properties of Ethylene Oxide compared with those of Oxygen Compounds of Similar Molecular Weight.* **O. Maass** and **E. H. Boomer.** (Am. Chem. Soc., J. 44. pp. 1709–1728, Aug., 1922.)—The following constants have been determined for carefully purified ethylene oxide: melting-point, − 111·3°; boiling-point, 10·73 ± 0·03°; critical temperature, 192°; molecular heat of vaporisation, 6·00 Cal.; Trouton's constant, 21·14; density at the boiling-point, 0·8827, giving the molecular volume, 49·85; total surface energy, 73·2; Ramsay and Shields' constant, 1·79; absolute viscosity, 0·005772 at − 49·8°, and 0·002927 at 9·3°; molecular viscosity at slope 0·0000323, 0·0412, and at slope 0·0000987, 0·0785. The results of vapour density measurements at 14 – 100° are given. Comparison of these physical properties with those of methyl ether, alcohol, and acetaldehyde brings out the ring structure of ethylene oxide. T. H. P.

2425. *Considerations of Probability applied to the Radiation Law.* **E. J. Gumbel.** (Zeits. Math. u. Mechanik, 2. pp. 286–296, Aug., 1922.)—Applies various criteria, based on the theory of probability, to the radiation formula of Planck, and the modification of it suggested by Nernst and Wulf [see Abs. 1414 (1919)]. The theory of errors, the distortion, and the correlation theory all lead to the conclusion that Rubens' experimental results are more consistently represented by the original Planck equation than by the suggested modification, although the latter, having an additional parameter, gives a smaller mean error. The radiation formula of Charlier is also found to be unsatisfactory. J. W. T. W.

SOUND.

2426. *Acoustic Topography near Organ Pipe.* **C. Barus.** (Nat. Acad. Sci., Proc. 8. pp. 96–100, May, 1922.)—In this experimental work the pipe was a closed brass pipe of pitch f''. The acoustic pressure is measured by the U-tube interferometer at various positions surrounding the pipe, and numerous graphs are plotted coordinating pressure and position. The work shows that when the reflecting surface is relatively near to the pipe the position of maxima and minima may be predicted as a case of ordinary interference and the wave-length computed satisfactorily. If the reflecting surfaces are relatively remote the positions of crests and troughs cannot, as a rule, be found by the same methods satisfactorily. [See Abs. 607 (1922).] E. H. B.

2427. *Sound Distribution Round a Pipe.* **C. Barus.** (Nat. Acad. Sci., Proc. 8. pp. 119–123, June, 1922.)—Describes by a large number of graphs the radial and cylindrical distribution of sound round the normal of an organ pipe placed vertically above a table. E. H. B.

2428. *Sound Radiation from Tuning-Fork.* **W. Burstyn.** (Zeits. techn. Physik, 3. 5. pp. 180–181, 1922.)—Discusses the enhanced effect obtained from a sounding tuning-fork when one prong is allowed to lie in a slot in a large plate, there being just sufficient clearance in the slot to allow the prong to vibrate freely. E. H. B.

2429. *Resonance Theory of Hearing.* **H. Hartridge.** (Nature, 110. pp. 9–10, July 1, 1922.)—The author feels that Ackermann is probably correct in stating that the first incoming sound wave sets all the resonators of the ear temporarily in vibration, and also that, as the sound waves continue, the vibrating resonators decrease in number until only those are left in motion that are executing either sympathetic or forced vibration in time with the incoming sound waves. The present author holds, however, that even after one complete sound wave there will be already a clearly-marked selection of the *in-tune* group of resonators. Also, taking the physiological effects into consideration, it is held that the threshold factor will definitely rule out all amplitudes below a certain value. E. H. B.

2430. *Binaural Audition.* **T. C. Fry.** (Phys. Zeits. 23. pp. 273–277, July 15, 1922.)—Discusses the problem of sound source location with special reference to the work of Hambostel and Wertheimer and that of R. V. L. Hartley. E. H. B.

2431. *Positive and Negative Pinhole Resonators.* **C. Barus.** (Nat. Acad. Sci., Proc. 8. pp. 163–166, July, 1922.)—Pinhole resonators with conical pinholes large end out and small end out are now described, and their behaviour tested. They are found to give oppositely-signed or reversed pressure changes at the various positions round the source of sound. Hence their name positive and negative. [See Abs. 1664 (1922).] E. H. B.

2432. *Foundations of Technical Acoustics.* **R. Berger.** (Zeits. Vereines deutsch. Ing. 66. pp. 709–715, July 22, 1922.)—A semi-popular treatment of the elementary principles of acoustics presented in a manner suitable for engineering or other technical applications. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2433. *Calculation and Discussion of the "Schrot" Effect.* **W. Schottky.** (Ann. d. Physik, 68. 2. pp. 157–176, July 20, 1922.)—Johnson [Abs. 1678 (1922)] has pointed out an error in Schottky's previous paper [Abs. 332 (1919)]. The present paper gives a new method of evaluating the integral concerned. This results in the introduction of a second correction factor of 2, which brings the value calculated for the elementary quantum to the right order of magnitude, the mean value of all the experimental results being very near the usually accepted value of $1 \cdot 56 \times 10^{-19}$ coulomb. A. W.

2434. *Atoms and Molecules,* II. *The Hydrogen Molecule.* III. **A. C. Crehore.** (Phil. Mag. 43. pp. 886–914, May for Part II, and pp. 1025–1038, June, 1922, for Part III.)—See Abs. 361 (1922).

2435. *On Electromagnetic Actions in an Isotropic System.* **L. Roy.** (Comptes Rendus, 174. pp. 1449–1450, June 6, 1922.)

2436. *Electrification on Breaking-up Water.* **J. J. Nolan** and **J. Enright.** (Roy. Dublin Soc., Proc. 17. pp. 1–11, Aug., 1922.)—Extension of previous work by Nolan [Abs. 1702 (1914)]. The charges previously found to be produced on creating new water-surfaces were not deemed sufficient to support G. C. Simpson's theory [Abs. 1078 (1909) and 1305 (1915)] of thunderstorms, that the electric separation is due to the break-up of raindrops. The present experiments go a great way to fill up this gap, when the water is very pure. The quantity of electricity associated with the formation of 1 sq. cm. of new water-surface is about 0·02 e.-s. unit. A. D.

2437. *Report on Atmospheric Electricity.* **E. Mathias.** (Ann. de Physique, 18. pp. 83–170, July–Aug., 1922.)—A summary of previous work on atmospheric electricity, the subjects considered including:—The electrical potential and conductivity of the atmosphere; determination of mobility of the ions and measurement of ionisation in the atmosphere; radio-activity of the atmosphere; study of the electrical conditions accompanying precipitation; explanation of natural phenomena such as thunder, lightning, and the aurora polaris; wireless disturbances and earth currents. A. W. L.

DISCHARGE AND OSCILLATIONS.

2438. *Effect of Temperature on Glow Discharge.* **L. Amaduzzi.** (Elettrotecnica, 9. pp. 483–486, Aug. 5, 1922.)—The author describes experiments on the discharge in a tube containing air at low pressure when the tube is immersed in a vaseline oil bath held at various temperatures from 0° to 230° C. and, in a second series of experiments, from − 180° to 350° C. A marked increase of discharge current was observed to follow the rise of temperature, particularly above 100° C. This increase in current was not due to conduction by the glass tube. The effect of the rise of temperature on the appearance of the discharge in the tube is described in the paper. J. W. T. W.

2439. *Variation in the Intensity of Current of Discharge in Vacuum Tubes due to Variation of Temperature.* **G. Todesco and L. Amaduzzi.** (Elettrotecnica, 9. pp. 507–512, Aug. 15–25, 1922.)—Four different tubes are employed in these experiments, in one of which a good portion of the discharge is concentrated in a small space and the tube is completely closed. This tube contains air at a pressure of 1·5 mm. Another tube is similar in construction to this, but is furnished with two stopcocks, enabling communication to be made with the pump and also with the gas generator. The other two are of much smaller section and are in the shape of an U. One is furnished with one stopcock, the other with two. Diagrams of these tubes are given and the experimental arrangements are described and illustrated. Experiments are described in which the temperature variation is between that of the surrounding air and 275°, for tubes containing air, hydrogen, and carbonic anhydride. A second series gives the data obtained with the same gases at temperatures between that of liquid air and 320°. In all cases the temperature quoted is that of the bath in which the discharge tubes are immersed. It is found that with the closed tube the variation in the intensity of the current as the temperature is raised cannot be represented by a straight line. The shape and section of the tube appears to exercise an important influence on the form of the curve obtained. In general, with one exception, the curves given agree in presenting first a convexity to the axis of the abscissæ and then a concavity. The temperature influence is much more marked for CO_2 than for H_2, and more in the case of the latter than for air. The curves for air and hydrogen are very similar, but the behaviour of CO_2 is very peculiar between temperatures − 150° and − 100°. The variations obtained in the colouration of the gases through which the discharge passes is also noted for the temperatures under consideration. A. E. G.

2440. *Absorption of Hydrogen by Elements in the Electric Discharge Tube.* **F. H. Newman.** (Phil. Mag. 44. pp. 215–226, July, 1922.)—A study was made of the behaviour of hydrogen in the presence of various elements in a discharge tube when a current was passing through it. The pressures of the gas in these experiments were lower than those previously used by the author [Abs. 1139 (1921)], but were much greater than those used by Langmuir and Campbell [Abs. 1459 and 1814 (1921)]. The results obtained are presented in tabular form, and show, among other things, that the mechanical deposition of gas on the walls of the discharge vessel will not account entirely for the disappearance of the gas, as is proved by the difference in the behaviour of nitrogen and hydrogen with phosphorus, sulphur, and iodine. Practically none of the nitrogen can be reliberated by heating, but a large proportion of the hydrogen is evolved. A. W.

2441. *Electronic Bombardment of Nickel.* **H. E. Farnsworth.** (Nat. Acad. Sci., Proc. 8. pp. 251–254, Aug., 1922.)—The investigation described in this paper deals with the following characteristics of nickel :—(1) The magnitude of the secondary electron current as a function of the primary velocity, and (2) the velocity distribution of the secondary electrons for any given primary velocity. A. B. W.

2442. *Positive-Ray Analysis of Heavier Constituents of the Atmosphere ; of the Gases in a Vessel in which Radium Chloride had been stored for* 13

Years, and of the Gases given off by Deflagrated Metals. **J. J. Thomson.** (Roy. Soc., Proc. 101. pp. 290–299, July 1, 1922.)—The paper contains an account of applications of the positive-ray method of analysis to several problems. The first is that of the heavier constituents of the atmosphere. It is shown that at least two constituents heavier than xenon are present in the atmosphere. The approximate values of the atomic weights are 163 and 260; the lighter of these is the more abundant, but the quantity of it in the air is very small compared with that of xenon. The source of these lines is discussed; on the whole, it seems most probable that they are due to molecules of krypton and xenon. These gases were observed in the residues of large quantities of liquid air which were lent by Sir James Dewar.

The second application of the positive-ray method was to the analysis of the gases in the tube in which radium chloride has been sealed for 13 years; the tube had been exhausted by Sir James Dewar before sealing. In the photographs obtained with this gas the helium line was very strong; there was no neon. There was, however, a faint line for which $m/e = 5$, due probably to a compound of helium and hydrogen. The P.R. analysis was also applied to gases which had stood over radium and also to the gases lit by deflagrating wires. From the study of the photographs obtained with these gases, quadruply charged atoms of oxygen and nitrogen were detected and triply charged atoms of oxygen, nitrogen, and carbon. The compound OH_4 was also detected carrying invariably a double charge. A. B. W.

2443. *Electric Arc between Carbon and Metals.* **A. Blondel.** (Comptes Rendus, 175. pp. 12–13, July 3, 1922.)—Discusses the conclusions arrived at by Dunoyer and Toulon [see Abs. 2314 (1922)], and concludes that, while in an arc between carbons the arc will not be maintained if the kathode is cooled, in an arc between carbon and metal, such as the Gabarini, where the kathode is kept cool by a stream of water, the necessary temperature must be attained by a very thin film of carbon deposited from the anode on the metal surface of the kathode. The arc then becomes an arc between carbon electrodes, and there is no difficulty in supposing that the carbon film on the kathode attains the high temperature necessary to maintain the arc. J. W. T. W.

2444. *Short Electric Waves Obtained by Valves.* **E. W. B. Gill** and **J. H. Morrell.** (Phil. Mag. 44. pp. 161–178, July, 1922.)—This paper describes an investigation into the oscillations which occur in hard valves when a Lecher wire system is connected to the grid and anode [see Abs. 908 (1920)]. When the grid is positive regarding the plate and filament, oscillations occur, the wave-lengths for a given valve depending on the relative potentials and the emission. These are detected by a second Lecher wire system with recording instrument and movable bridge for tuning. When the latter circuit (wavemeter) is in tune with the primary the current in the latter drops owing to absorption of energy. The grid voltage was gradually increased and maximum current values found for various grid voltages. The wave-lengths of the oscillations decreased from 582 cm. at 16 volts to 233 cm. at 114 volts. These wave-lengths correspond to the free oscillations of the system consisting of Lecher wires and valve electrodes. Another series of experiments was conducted, the filament emission and anode voltage being constant and the grid voltage varied to obtain maximum current for the wave-lengths determined in the previous tests. $\lambda^2 v$, where v is the grid voltage respecting the filament, was found to be constant. Experiments were also made to ascertain the range of wave-lengths for given grid potentials, with varying emission and constant anode voltage and vice versa. These showed that the wave-length was reduced with augmented emission and increased with increase in anode voltage.

A simple theory is given to explain the oscillations under the above conditions. It is shown that no special hypotheses are essential provided the time taken for the electrons to pass between the electrodes is taken into account, as this time is of the same order as the period of the oscillations.

A note is added relating to the determination of the ionisation potential of gases, and it is shown, as a deduction from the experimental evidence obtained, that abnormal variations in plate potential usually associated with gaseous molecular phenomena may under certain conditions be due to short-wave oscillations. N. W. M.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2445. *Studies in Electric-Endosmose.* **A. Strickler** and **J. H. Mathews.** (Am. Chem. Soc., J. 44. pp. 1647–1662, Aug., 1922.)—Practically all the previous work on electric-endosmose has been with water and aqueous solutions, and this has been extended in the present investigation to 9 typical organic solvents (acetone, amyl alcohol, nitrobenzene, pyridine, benzaldehyde, *n*-butyl alcohol, furfural, isopropyl alcohol, and *o*-nitrotoluene), using a modified Briggs' apparatus. Since the publication of Briggs' bibliography in 1917 and his experimental results in 1918 but little has been reported. Loeb has carried out experiments to determine the influence of electrolytes on the electrification and the rate of flow of water through colloidal membranes, and the cause of this influence; while articles by Gerard and Morax and by Frank and Withrow have also appeared [see Abs. 1348 (1920)]. Experimental details are included, with tables and curves of results. In the theoretical discussion of the latter, an adsorption orientation theory has been suggested to explain the establishment of the original charge at the surface of contact of the membrane and solvent. This states that the molecules of the solvent, upon adsorption, are oriented upon the membrane surface, producing a charge by their polarity. If dissociated molecules are present they affect the membrane charge by specific adsorption of the ions produced. This does not eliminate adsorption, but suggests a more comprehensive view of the mechanism for the establishment of the original charge. The following conclusions were reached :—(1) The permeability of the membrane is an important factor in determining endosmotic flow. (2) It is possible to duplicate membranes of filter-paper when using non-aqueous solvents. (3) The endosmose rate (as measured) is not quite a linear function of the voltage when varied over a wide range. (4) The effect of acid and alkali can be explained on the assumption of adsorption, making due allowance for concentration and chemical change. (5) Briggs' result as to temperature effects with water have been confirmed with non-aqueous solvents. (6) The valence rule does not hold with the non-aqueous solvents studied. (7) The order of adsorption of ions and their relative adsorption varies with the solvent employed. (8) The concentration curve exhibits a maximum with non-aqueous solvents, and the flow at low concentration is in the same direction as that of the pure solvent. (9) The addition of water to non-aqueous solutions changes the endosmose in the direction it would manifest in pure water, the first additions showing the greatest effects. (10) The direction of endosmose (as here measured) is not determined by the dielectric constant ratio, although this probably does measure the magnitude of flow. (11) The Hofmeister series is not consistent when considering endosmotic effects in non-aqueous solvents; and variations of order can be explained only by assuming a specific effect due to the nature of the solvent. The order of the kations is in acetone, $Mg > K > Na > Li > NH_4$; in furfural, $Li > Mg > Na > NH_4 > K$; and in *n*-butyl alcohol, $K > Na > Mg > NH_4 > Li$. H. H. Ho.

2446. *Specific Inductive Power of Mercury Vapour.* **Bedeau.** (Comptes Rendus, 175. pp. 147–148, July 17, 1922.)—When the capacity of an oscillating circuit with sustained waves is placed in mercury vapour, these waves are affected. Measurements were taken at 400° C. at atmospheric pressure, using the same method as employed for air. Two circuits of sustained waves, A and B, are given the same wave-length ($\lambda = 1000$ m.), the regulation being obtained by a variable capacity in circuit B. If KC be the unknown capacity of circuit A, K being the specific inductive power of air, and if this capacity is replaced by another variable C', standardised, so that the two circuits still have the same wave-length, we get $KC = C'$. If $\Delta C'$ be the variation of C' when air is replaced by mercury vapour at the same temperature, then if K' is the dielectric constant of this vapour, we have $(K' - K)C = \Delta C'$. It is, of course, necessary to take various precautions in making these measurements, *e.g.*, eliminating all traces of water vapour. In the result, the specific inductive power verifies well Maxwell's formula, which gives $K' = 100{,}074$. T. C. H.

2447. *The Effect of Absorbed Gas on the Conductivity of Glass.* **V. Bush** and **L. H. Connell.** (Frank. Inst., J. 194. pp. 231–240, Aug., 1922.)—This paper presents the results of an investigation on the electrical properties of glass carried on during the past two years in the Research Laboratories, Department of Electrical Engineering, Massachusetts Institute of Technology. Langmuir measured the amount of gas removed from glass by heating in vacuum. He found this gas to consist principally of water vapour, and also showed that the total amount liberated varied with temperature up to the softening point of the glass. On the assumption of absorption the amount of water obtained corresponded, for a representative specimen, to a surface layer 55 molecules deep. Some penetration is hence evident, and Langmuir concludes that a solution of the water in the glass takes place. The results of a number of other investigations indicate a similar conclusion. The present investigation was undertaken to determine whether penetration occurred throughout the volume and whether any light could be thrown on the electrical conductivity of vitreous materials. The paper is illustrated with diagrams of the apparatus employed and several tables of curves. It is believed that the measurements made show definitely that gases penetrate throughout the volume of glass or quartz, and thus affect its electrical conductivity and probably other properties. A considerable improvement in insulating value or dielectric loss can be obtained by vacuum treatment, and part of this improvement is apparently permanent. Some penetration of moisture into the body of the glass occurs at ordinary temperatures. E. F

2448. *Electromotive Force by Light on Argentite.* **H. H. Sheldon** and **P. H. Geiger.** (Nat. Acad. Sci., Proc. 8. pp. 161–163, July, 1922.)—While obtaining data on the change of resistance of argentite (Ag_2S) from Saxony and from Mexico) with change of intensity of illumination, it was observed that under proper conditions a deflection of the galvanometer occurred on illumination without any external e.m.f. being applied to the circuit. A graph is given showing that this photo-electromotive force increases at first rapidly with the intensity of the incident light, but afterwards asymptotes to a limiting value of about 0·0133 volt. E. H. B.

2449. *Variation of Photoelectric Current with Thickness of Metal.* **O. Stuhlman, Jr.** (Phys. Rev. 20. pp. 65–74, July, 1922.)—Describes experiments on the intensity of the photoelectric current from films of platinum and silver of various thicknesses deposited on quartz. The thicknesses used ranged from transparent films to opaque films. In all cases it was found that the photoelectric current at first increased with the thickness of the film to a first maximum in the region of a 30μμ thickness. It then fell to less than half of its maximum value, and subsequently rose again very rapidly. The same qualitative effects were shown by both metals. The author concludes that (*a*) the photoelectric current is not, in general, proportional to the amount of light absorbed; (*b*) the greater the wave-length of the existing radiation the greater the depth to which absorption of light and emission of current are proportional; (*c*) in the case of silver the variation in optical transmission runs parallel to the variation in the photoelectric current as the thickness of metal changes; (*d*) optical absorption of the light may take place without photoelectric emission; (*e*) photoelectric emission is not caused by the absorption of energy, and the light acts only as an agent in setting the electrons free. J. W. T. W.

2450. *Theory of a New Transformation Phenomenon in Metals.* **G. Borelius.** (Ann. d. Physik, 68. 1. pp. 67–72, July 20, 1922.)—Borelius and Gunneson have recently described some thermoelectric peculiarities of quenched iron (Z transformations) [Abs. 1904 (1922)]. The position of the *n*th transformation on the absolute temperature scale, as they occur at equal temperature differences, is given by $T_n = A . n$, where A is a constant. In addition to electrolytic iron the phenomenon has been observed in tungsten. For Fe the mean value of A is 97° and for W 81°. In the present paper Borelius attempts a theoretical explanation based on the quantum theory. The hypothesis is made that the Z transformation of the *n*th order occurs at that temperature where the number of atoms which possess at least *n* quanta is a definite fraction ($1/r$) of the total number of atoms. He arrives at the result $T_n = (h\nu/k . 3 \log r) . n$. Using atomic volume and melting-point data for Fe and W in calculating $h\nu/k$, the value deduced for r is 4·6 in the case of Fe and 3·4 for W. Thus a transformation occurs when approximately ¼ of the atoms attain a new quantum number. L. L.

2451. *ZnSCu-Phosphore.* **B. Gudden** and **R. Pohl.** (Ann. d. Physik, 68. 2. pp. 154–156, July 20, 1922.)—It has previously been found that the ZnSCu-phosphore shows an increase of dielectric constant when illuminated [Abs. 85 (1921)]. This effect has been further investigated by Wilde, who has found that the effect shows a maximum at about 140° C. The time variations of the effect are for all temperatures and wave-lengths similar to the brightness variations of the material. A full account of the investigation will be given later. [See Abs. 1820 (1921).] A. W.

2452. *Magnetic Pivot and Self-Charging Electroscope.* **C. E. S. Phillips.** (Phys. Soc., Proc. 34. p. 213, Aug., 1922.)—In the first of two examples a steel knitting-needle stood vertically on a glass plate, its upper end being supported (without touching) by a permanent magnet. The friction of the system is thus reduced to a minimum. As the needle was very free to rotate about its axis, if a short arm was attached radially to its centre and the needle slightly inclined, a control was afforded by the arm moving so as to place its mass centre as low as possible. The second example was a small sewing-needle with its point resting lightly on the surface of mercury, the upper end being supported, as before, by a magnet.

In the electroscope, the occasional adhesion of the gold leaf to the charged surface with which it periodically comes in contact is overcome by coating the object touched with a layer of fine arc-lamp carbon powder. The arrangement has been made to give a sharp sound, audible in a telephone, when the leaf strikes the powdered electrode. This is being utilised in the design of a recording electroscope. T. C. H.

2453. *Comparison of Prototypes of the International Ohm.* **R. Jouaust.** (Rev. Gén. d'El. 12. pp. 128–129, July 29, 1922. Comptes Rendus, 175. pp. 94–96, July 10, 1922.)—Gives the results of an intercomparison carried out at the Laboratoire Central d'Electricité between eight prototype mercury standards. The standards were compared two by two in all combinations using a Kelvin double bridge. The mean difference between the resistances as measured and those calculated from the dimensions were $1\cdot9 \times 10^{-5}$ ohm. The differences found for the individual pairs, as compared with those calculated, do not differ by more than $4\cdot4 \times 10^{-5}$. J. W. T. W.

2454. *The Neon Tube as a Means of Producing Intermittent Currents.* **S. O. Pearson and H. St. G. Anson.** (Phys. Soc., Proc. 34. pp. 204–212, Aug., 1922.)—The paper relates to an experiment in which a neon tube and a condenser in parallel are connected in series with a high resistance and source of current. In these circumstances intermittent current is found to pass through the lamp, and the conditions are discussed which govern the frequency and duration of the resulting flashes. The authors claim for the device here described that it provides a very simple and inexpensive means of producing intermittent currents without the use of any moving mechanism or contacts, and that it should prove particularly useful over the audible range of frequencies. Among the suggested possible uses of the arrangement are: (1) Audio-frequency—telephonic measurements; stroboscopic measurements. (2) High frequency—radio communication and measurements. E. F.

2455. *Calculation of a Primary Standard of Mutual Inductance of the Campbell Type and Comparison with the Similar N.P.L. Standard.* **D. W. Dye.** (Roy. Soc., Proc. 101. pp. 315–332, July 1, 1922.)—The construction of the new standard differs only in minor details from the N.P.L. standard, the primary being wound in spiral grooves cut on a marble cylinder, and the secondary being a ring-shaped coil of many layers. All the measurements of the various dimensions were made with the greatest possible accuracy and the value calculated for the mutual inductance was found to be in excellent agreement with the value obtained by comparison with the N.P.L. standard. Full details of the calculation and comparison are given. It appears that both standards are accurate to within about 1 part in 100,000, in their values calculated from the dimensions as measured in terms of the N.P.L. standards of length. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

2456. *Harmonic Analysis by Selected Coordinates.* **A. E. Clayton.** (Electrician, 84. pp. 176–179, Aug. 18, 1922.)—In a previous paper [Abs. 997 (1921)] Runge's simplification of Perry's schedule method of harmonic analysis was considered and expressions were obtained for the amplitudes of the sine and cosine terms. The present paper gives an account of a schedule method capable of any required accuracy, and the schedules used occupy only 40 to 50 % of the space necessary for Runge schedules giving the same accuracy. The labour involved in the calculations is reduced by 25 to 30 %. The schedules are so arranged that one and the same tabular form can be utilised for either sine or cosine terms. Typical schedules are given for the analysis of waveforms containing odd harmonics only up to the 31st and the 63rd harmonics respectively. A. W.

2457. *Magneto Chemistry of the Arsenic Acids.* **P. Pascal.** (Comptes Rendus, 174. pp. 1698–1700, June 26, 1922.)—The bearing of the diamagnetic qualities of arsenic compounds is discussed in relation to molecular formulæ. W. R. C.

2458. *Effect of Compression on Susceptibility of Feebly Magnetic Bodies.* **E. Wilson.** (Roy. Soc., Proc. 101. pp. 445–452, Aug. 1, 1922.)—Specimens of magnetite, dolerite, and other minerals of size 4 × 1 × 1 in cms. were subjected to compression forces by means of a weight placed on a horizontal iron lever. The bars were subjected to stresses varying from 0 to about 1200 kgms. per sq. cm., and the volume susceptibility was measured in the direction of the stress and perpendicular to this direction. The bars were magnetised by means of an electromagnet whose stalloy core was made from nine stampings of ring form with a gap for the test piece; a field of 352 c.g.s. per ampere could be applied. It was found that in certain varieties of magnetite in which the susceptibility has a pronounced maximum, increase of pressure causes a diminution of susceptibility which may be of the order 50 per cent., the magnetising force being of the order which produces maximum susceptibility. The gradient is less for other magnetic forces. The remanent induction and the coercive force are also reduced by pressure. In certain specimens pressure caused no change of susceptibility. The susceptibility at right angles to the compressive force increases slightly in those cases in which pressure causes any change. [See Abs. 931, 1613 (1921), also 737 (1910).] G. E. A.

2459. *Experimental Confirmation of the Kinetic and Molecular Theories of Magnetism.* **J. R. Ashworth.** (Nature, 110. pp. 10–11, July 1, 1922.)—Curie's law states that ferromagnetics above the critical temperature behave in such a way that the susceptibility k is inversely proportional to the absolute temperature T. The physical meaning of this law is that when the molecular magnets have complete freedom of rotational movements the energy of magnetisation is then only opposed by the energy of thermal agitation, and consequently any given state is a state of equilibrium. Below the critical temperature complications introduced by the mutual magnetic actions of the molecules, and by the approach to a saturation limit, have obscured any such simple law. It is, however, possible to eliminate, or allow for, the effects of these disturbing factors and to make experiments, under hysteresis-free conditions, upon the variation of susceptibility with temperature. Experiments of this kind have been carried out on iron and nickel, with the result that the Curie law, with certain limitations, is found to apply to the ferromagnetic state, and the relation $k\mathrm{T} =$ a constant is approximately satisfied, but with the constant now of a very different magnitude from the former one. There is, however, this simple and important relation between the constants in the two states—their ratio is *the kinetic energy per unit of temperature per gram of two degrees of freedom*, and is thus immediately connected with the gas constant R. This result shows that the change from the ferromagnetic to the paramagnetic state is quantitatively explicable as due to the acquisition of the kinetic energy per unit temperature required for the two degrees of rotational freedom which are effective in controlling magnetic susceptibility. Thus there is proof from magnetic data alone, independently of thermal data, that the change at the critical temperature from ferro- to para-magnetism is due to the gain of energy associated with two degrees of freedom. This acquisition of energy-content makes itself evident in the increase of specific heat which ferromagnetics show at and above the critical temperature, and is quantitatively in agreement with the magnetic result. The results are also a confirmation of the simple view advanced by Ewing in his earlier papers on the molecular theory of magnetism, in which he suggests that the loss of ferromagnetic qualities may be caused by the oscillations of the molecular magnets which become wider and wider up to the critical temperature, at which point they pass from vibration to rotation. A. W.

2460. *Relation of the Magnetic and Mechanical Properties of Rolled Heusler Bronze (Manganese-Aluminium-Copper).* **F. Heusler.** (Zeits. f. Physik, 10. 6. pp. 403–404, 1922.)—This bronze, if plunged red-hot into water, is non-magnetisable and at a low temperature changes to a magnetisable form showing minimal hysteresis; if, however, it is cooled very slowly from a red heat, the bronze assumes great coercive power. The hardness, tensile strength, and expansion also depend entirely on the mode of cooling. When slowly cooled it becomes so hard that it cannot be worked with the best steel, whilst the quenched metal is readily wrought. For the soft, hard, and semi-hard metal, the tensile strengths in kilos per sq. mm. are respectively 66, 96, and 75, and the corresponding elongations 21·5, 0·5, and 9·0 per cent. [See Asteroth, Abs. 683 (1908).] T. H. P.

2461. *Measurement of H by an Electromagnetic Magnetometer.* **F. E. Smith.** (Roy. Soc., Phil. Trans. 223. pp. 175–200, Aug. 2, 1922.)—After referring to previous measurements by Watson, Watanabe, and Barnett [Abs. 1723 (1902) and 531 (1921)], the construction and working of a magnetometer of the Helmholtz-Gaugain type is described, the principle of which was given by Schuster [Abs. 1902 (1914)]. The coils of the system carry a current i which produces a horizontal field of intensity Fi, greater then H; if the two fields are almost in opposite directions, and the needle is at right angles to the meridian, $H = Fi \cos a$, where a is the acute angle between the two field directions. The coils of the instrument are four in number, each containing 12 turns, of 30 cm. radius, of bare copper wire wound on a marble cylinder capable of rotation round a vertical axis. The needle is 1 cm. long and 5 sq. mm. in section, and is suspended by a quartz fibre. When the needle is deflected, the fibre is turned through an equal angle to remove the torsion. The current i is determined in absolute measure by means of a current weigher. After adjustment of the current, a measurement of H with calculation complete takes less than four minutes, the total probable error being about ± 4 parts in 100,000. A full account is given of the construction of the various parts, the measurements of the coils, tests of the uniformity of the field at the needle, calculation of the constant F, examples of measurements of H with the instrument, and comparison of the results with values obtained from a magnetograph and from a Kew magnetometer. G. E. A.

2462. *Magnetic Survey of India.* **E. C. J. Bond.** (Survey of India Records, 15. pp. 75–97, 1919–1920.)—Information is given in regard to the observatories at Dehra Dun, Toungoo, Kodaikanal, and also a classification and dates of magnetic disturbances in 1919. W. R. C.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2463. *Comparisons between the Therapeutic Photograph and Ionisation Effects of Ultra-Violet and of Beta Radiations.* **L. H. Clark** and **B. D. Watters.** (Röntgen Soc., J. 18. pp. 119–133; Disc., 133–134, July, 1922.)—The object of this research was to find whether there is any connection between one biological effect of the above radiations and two physical effects, namely photographic action and ionisation. As a source of ultra-violet radiation a mercury arc was used enclosed in a quartz vessel and then in a large box with an aperture. The source of β-rays was a capsule containing 24 mgr. of radium bromide. Exposures to the mercury arc were made upon the human arm. The quantity of radiation received varies with the time of radiation and voltage of the arc. A table is given showing the energy used and the latent period before the appearance of erythema, and the authors conclude that the energy consumed by the arc serves to measure the probable extent of the skin reaction.

The skin reaction is then compared with data given by Mottram and Russ for radium radiation. The outstanding feature is the difference of time required by the two reactions, the latent period of β-rays being approximately 2000 times that of ultra-violet light, and whereas with the latter increased exposure greatly decreases the latent period, with β-rays increased exposure does not noticeably reduce the latent period. A fluorescent skin effect was noticed, and this decreases when a skin reaction was obtained, and this loss was persistent for several months over the same patch of skin.

The authors then discuss the comparison of skin effect and photographic effect. The effect of the ultra-violet light varies with the wave-length, and it is probable that only a limited wave range gives rise to therapeutic effects. Exposure of skin was made to rays previously analysed by a spectroscope, and the results indicate that only wave-lengths below λ2490 are most effective in physiological action, and that care must be taken in using photographic action to indicate physiological action.

Since the electroscope is the method *par excellence* to determine the effect of β-rays, the authors carried out experiments to see whether this method was applicable to other radiations, as ultra-violet. A special type of electroscope was used (illustrated), having a large lead block to protect the electroscope from the rays' effects, radiations being admitted to the air below the electroscope via a cylindrical tunnel through the lead. The intensity of the β-rays was found to be roughly inversely as the distance, and it was found the ionisation currents due to 1 sq. cm. of mercury arc was only 0·75 % of that due to the same area of radium source, and hence it is considered the ionisation of air caused by the mercury arc is negligible. A further apparatus is then described, the object of which was firstly to see if it is possible to use the photoelectric action of light upon a metallic surface (zinc) as a measure of the therapeutic action, and secondly to determine whether there is any marked photoelectric action with skin which would support the photoelectric theory of the resulting erythema. Results show the photoelectric effect is strongest for a wave-length of λ2536, and that there is a correspondence between the photographic and photoelectric actions of those radiations most powerful in their action upon skin, and it would appear that in the photoelectric activity of a metallic surface (zinc) we have a powerful method of measuring the therapeutic effect; but a serious objection is the occurrence of "fatigue" of the metal until the laws governing the variation of the action are known. Further research is being carried out in this connection.

As regards the theory of skin reaction, it was found the ionisation from skin was 450 times smaller than from a zinc plate, and hence the occurrence of any considerable photoelectric effect with skin is very small. Also a further experiment in which the arm was exposed under the action of a strong electric field gave no variation of the resulting erythema action, and since the photoelectric effect is very dependent in the case of a metal to the state of electrification of the surface, the connection between skin reaction and photoelectric reaction due to ultra-violet light is obscure. A discussion on the results followed. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2464. *Aeration of Quiescent Columns of Distilled Water and of Sodium Chloride Solutions.* **W. E. Adeney, A. G. G. Leonard, and A. Richardson.** (Roy. Dublin Soc., Proc. 17, pp. 19–28, Aug., 1922.)—The aeration of quiescent bodies of water, fresh or salt, under natural conditions is effected by a process of mixing of the exposed layer with the unexposed portions of the water to depths of at least 10 feet. The process of mixing is caused by the downward "streaming" of the constantly changing layer of water exposed to the air, and proceeds more rapidly and more uniformly downwards, to depths of at least 10 feet, in salt water than in fresh water. The rate at which the streaming proceeds depends largely, but not entirely, on the rate at which concentration and cooling of the surface layer are brought about by evaporation from it. The streaming, and hence the mixing, are more rapid at and above 10° than at lower temperatures; they vary with the concentration of the solution, being at a maximum for 1 per cent. of sodium chloride. T. H. P.

2465. *Mechanism of Metallic Oxidation at High Temperatures.* **N. B. Pilling** and **R. E. Bedworth.** (Chem. and Met. Eng. 27. pp. 72–74, July 12, 1922. Paper read before the Inst. of Metals Division of Am. Inst. Mining and Met. Eng., Rochester, June, 1922.)—The authors show that the rapidity of oxidation of metals in heated atmospheres is not determined by any property of the metal, but by some combination of physical properties of the oxide formed and its ability to absorb and diffuse oxygen. The base or oxidising metals may be divided into two classes, according to whether the oxide film occupies more space than the original metal or otherwise. If the oxide layer occupies more space, it forms a tight-fitting, solid sheet; if the reverse is the case, there is more space available within the original metallic dimensions than the oxide density requires and a porous layer results which does not prevent further oxidation in the same manner as the former type of oxide does. The critical density ratio between the metal and the oxide is given in the expression Wd/wD, where W is the molecular weight of the oxide formed, w is the formula weight of the metal, D is the density of the oxide formed, and d density of the metal. The cellular oxide structure results when this ratio is less than unity and the solid crystalline oxide when it exceeds unity.

The way in which the rates of oxidation change with temperature is equivalent to the temperature change in diffusivity of oxygen through oxide, as the corresponding change in oxygen solubility appears to be slight. The quadratic rate constant (isothermal) for all the metals examined is related to the temperature of oxidation according to the type equation: $k = AT^n$, a parabolic equation in which k is the rate constant, T the absolute temperature, and A and n are characteristic constants. C. O. B.

2466. *Crystal Structure of Solid Solutions.* **E. C. Bain.** (Am. Inst. Mining Eng., Trans. [15 pp.], Feb., 1922.)—A solid solution forms by replacement of solvent atoms by solute atoms. If the pure solute is of a different crystal type from the solvent, the parent lattice changes very little in dimensions. In such cases a limit of solubility is reached, at which point a new lattice is formed, which may be an intermediate, or the lattice of the solute. Intermediate lattices, based on weak compounds probably, are present in the complex series. When two metals, alike in crystallographic type, form continuous solid solutions there may be a gradual change in lattice size from one pure metal to the other. Other supposed continuous isomorphous series are actually composed, for some range, of two separate crystalline phases. Both forms are likely in the same grain. Thermal treatment may shift the range of overlapping lattices toward one or the other pure metal. The effect is most noticeable if one of the pair of metals is allotropic. W. R. C.

2467. *Constitution of Binary Zinc-Base Alloys.* **W. M. Peirce.** (Am. Inst. Mining Eng., Trans. [26 pp.], Feb., 1922.)—The present work has been done in an endeavour to correlate and complete the data on the constitution of alloys of zinc with other common metals, dealing exclusively, however, with the zinc-rich alloys in which the zinc content is between 90 and 100 %. The investigation has included the systems lead-zinc, cadmium-zinc, iron-zinc, copper-zinc, aluminium-zinc, nickel-zinc, manganese-zinc, cobalt-zinc, tin-zinc, and magnesium-zinc. The important ternary system, zinc-lead-cadmium, and the zinc corners of other ternary systems have been investigated in connection with this work, but are not dealt with here. W. R. C.

2468. *Variation of Properties of Alloys in a Two-Phase Field.* **L. Guillet** and **M. Ballay.** (Rév. de Mét. 19. pp. 416–421, July, 1922.) —The properties of an alloy situated in a two-phase field can generally be deduced from the properties of the two phases and the concentration. The property-composition curve is generally approximately linear if the variable is suitably chosen.

(1) *Microstructure.*—The microscopic appearance is a linear function of the percentage volume of the two constituents, but generally not of the percentage weight.

(2) *Density.*—The density is a linear function of the volume composition, while the specific volume is a linear function of the weight composition.

(3) *Dilatation.*—This also varies linearly with the volume composition.

(4) *Electrical Conductivity and Resistance.*—The variation of these properties is very complicated, but it is found experimentally that the conductivity is a linear function of the percentage volume.

The same is true of the (5) *Temperature Coefficient*, and (6) the *Thermo-electric Power.*

(7) *Magnetic Susceptibility* and (8) *Permeability.*—These vary linearly with the percentage volume.

(9) *Specific Heat* varies linearly with the weight per cent.

(10) *Thermal Conductivity.*—A linear variation when expressed in terms of the volume per cent.

(11) *Electromotive Force of Solution.*—This is that of one or other of the phases and is unaffected by the presence of the second.

(12) *Vapour Pressure.*—This is constant (at constant temperature) all through the field.

(13) *Mechanical Properties.*—So many factors intervene to affect the mechanical properties that only theoretical considerations can be applied, but, other things being equal, these may be said to vary linearly with the volume composition.

The paper ends with a discussion of various methods of converting weight per cent. into atomic per cent. J. L. H.

2469. *The Liquidus Curves of Binary Alloy Systems.* **A. Portevin.** (Rev. de Mét. 19. pp. 422–424, July, 1922.)—There exist two exceptions to the rule that each branch of the liquidus corresponds to the separation of a separate phase. The first exception is the case of a compound which melts without dissociation. The liquidus then consists of two separate curves which meet in a point. The second case is that in which there exists a field of two insoluble liquids. The liquidus below this consists of an horizontal line which joins two sloping branches. Some theoretical considerations attached to these cases are discussed. J. L. H.

2470. *Electrometric Titration in Acidimetry and Alkalimetry.* **P. F. Sharp with F. H. MacDougall.** (Am. Chem. Soc., J. 44. pp. 1193–1196, June, 1922.)—The authors have used lead amalgam and cadmium amalgam for electrodes, and have prepared a series of half-cells which are electromotively equivalent to hydrogen electrodes in contact with solutions in which the hydrogen ion concentrations are, respectively, 10^{-4}, $10^{-4.7}$, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9} and 10^{-10}. The object of the investigation was to find a number of constant and reproducible electrodes which could be used in titration. Pinkhof had already constructed various cadmium electrodes with the same object in view. The authors found that cadmium electrodes were best adapted for the purpose. W. R. C.

2471. *Influence of a Catalyst on the Thermodynamic Quantities Regulating the Velocity of a Reaction.* **E. van Thiel.** (K. Akad. Amsterdam, Proc. 25. 5 and 6. pp. 199–209, 1922.)—In direct contradiction to the conclusions arrived at by Trautz and by Lewis, it is shown that a catalysed reaction may have a temperature coefficient and an energy increment greater than those of the same reaction in absence of catalyst. The results are given of velocity measurements of the acetylation of diphenylamine at various temperatures, both without catalyst and in presence of *p*-bromobenzenesulphonic or *p*-toluenesulphonic acid as catalyst. These support Scheffer's theory, and appear to indicate that, with a low catalyst concentration, the number of molecular collisions of the same kind as occur in the non-catalysed reaction remains the same, collisions of another kind being added to them. The catalytic effect of the sulphonic acids is probably due largely to its directive action, this being the result of its affinity towards the reaction components. T. H. P.

2472. *Dislocation Theory of Catalysis.* **J. Böeseken.** (K. Akad. Amsterdam, Proc. 25. 5 and 6. pp. 210–215, 1922.)—When an alcoholic solution of benzophenone, kept saturated with oxygen, is exposed to violet light, the alcohol is oxidised to aldehyde and water, the ketone remaining unchanged. Further, when the concentration of the ketone exceeds a certain limiting value, the velocity of the reaction becomes independent of the concentration and proportional to the square of the intensity of the light and to the first power of the concentration of the alcohol. It is pointed out that the ideal catalysts are those which are not fixed in intermediate reactions, the real catalysis being the interaction between the catalyst and the molecules, this being distinct from the formation of a compound; to such interaction the name *dislocation* is applied. In the above reaction the ketone is first activated by the light to photo-ketone, which then reacts with the alcohol, two atoms of the latter becoming activated; this second reaction, which probably takes place with the velocity of light, is the real catalysis, that is the dislocation. These conclusions are discussed in relation to Scheffer's theory. T. H. P.

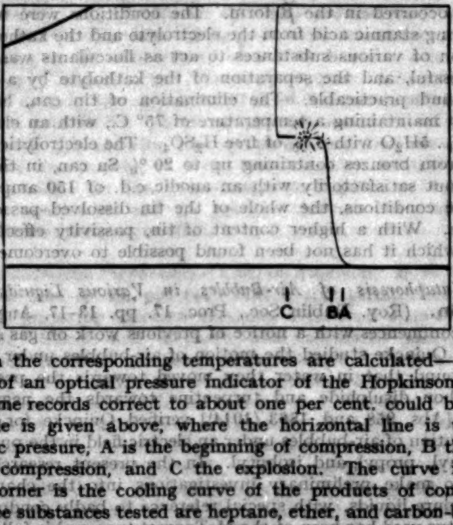
2473. *Ionisation Constants of Hypochlorous Acid.* **W. A. Noyes** and **T. A. Wilson.** (Am. Chem. Soc., J. 44. pp. 1630–1637, Aug., 1922.)—According to Stieglitz (1901) hypochlorous acid is an amphoteric compound with two ionisation constants, k_a for the acid $\mathrm{H^+ClO^-}$, and k_b for the base $\mathrm{Cl^+OH^-}$. These constants can, by Washburn's formula, be derived from conductivity measurements. The authors prepare their acid after Jakowkin and determine the conductivity by Kohlrausch's method, having in vain attempted to apply the method of Newbery [Abs. 78 (1919)]. Hypochlorous acid and sodium hypochlorite yield $k_a = 6\cdot7 \times 10^{-10}$; the value of k_b proved too small for determination by the change in the conductivity of 0·0001 N nitric acid when hypochlorous acid is added to it. The vapour phase of hypochlorous acid is found to contain the monoxide $\mathrm{Cl_2O}$ of Pelouze (1843) and not the hypochlorous acid HClO. In the amphoteric ionisation of the acid the hydrogen and hypochlorite ions preponderate, but enough positive chlorine ions are present to form monoxide by combining with the hypochlorite ions. On the Lewis-Langmuir hypothesis $\mathrm{Cl_2O}$ should be a non-polar compound, and the positive chlorine ion could then only hold 6 electrons in its outer shell. H. B.

2474. *Electrolytic Preparation of Calcium Amalgam.* **B. S. Neuhausen.** (Am. Chem. Soc., J. 44. pp. 1445–1447, July, 1922.)—The electrolytic method of preparing calcium amalgam has been found to be very troublesome. Smith and Bennett used saturated calcium chloride solution and saturated calcium acetate solution. They were troubled, however, by the foaming of the solutions and discolouration. The present author concludes that while the calcium-ion concentration should be kept sufficiently high to have a minimum discharge of the hydrogen ion, the smaller the concentration of calcium ions the less the chance of precipitation of calcium hydroxide, which proved to be so troublesome to Smith and Bennett. The author uses a crystallising dish about 25 cm. in diameter, the bottom of which is covered with mercury to serve as a kathode. The anode is a piece of platinum foil (2 × 4 cm.), parallel to and about 4 cm. above the mercury surface. A solution of 1·75 M calcium chloride was found most satisfactory. The current was 3·5 amperes. There was no foaming or darkening of the solution. The amalgams obtained contained 0·069 % to 0·075 % of calcium; the current of efficiency was about 65 % and the p.d. was 4 to 6 volts. W. R. C.

2475. *Electrolytic Separation of Copper-Tin Alloys.* **P. Weise.** (Zeits. Elektrochem. 28. pp. 327–341, Aug. 1, 1922.)—An investigation is made of the phenomena attending the electrolytic separation of copper from copper-tin alloys, with particular regard to the conditions which apply in copper refining. The potential relation in normal sulphuric acid of alloys of copper with atomic percentages of tin up to 24 is approximately that of pure copper, while alloys with atomic percentages of from 24 to 26 of tin show a rapid fall of potential towards the value for tin. Experiments were conducted with a vessel containing an anode of bronze, an electrolyte of copper sulphate and sulphuric acid, as employed in copper refining, and a kathode of copper. A portion of the tin was found to remain in the anode slime, which also contained particles of mechanically-disintegrated copper, while the remainder passed into the electrolyte. The solution of tin from the anode was found to be increased by rotating the anode and by increasing the content of sulphuric acid. In the early stages the tin dissolves in the form of stannic ions, which are later accompanied by some stannous ions. The existence of tin in the electrolyte as colloidal stannic acid was demonstrated by the ultramicroscope, dialysis through porous membranes and determination of the direction of migration in an electric field. An approximate estimate of the size of the particles showed that the stannic acid, both in the slime and the electrolyte, occurred in the β form. The conditions were investigated for eliminating stannic acid from the electrolyte and the kathode deposit. The addition of various substances to act as flocculants was found not to be successful, and the separation of the katholyte by a diaphragm was not found practicable. The elimination of tin can, however, be achieved by maintaining a temperature of 75° C., with an electrolyte of 15 % $CuSO_4 . 5H_2O$ with 5 % of free H_2SO_4. The electrolytic separation of copper from bronzes containing up to 20 % Sn can, in this way, be brought about satisfactorily with an anodic c.d. of 150 amps. per m.^{2}. Under these conditions, the whole of the tin dissolved passes into the anode slime. With a higher content of tin, passivity effects occur at the anode which it has not been found possible to overcome. J. N. P.

2476. *Cataphoresis of Air-Bubbles in Various Liquids.* **T. A. McLaughlin.** (Roy. Dublin Soc., Proc. 17. pp. 13–17, Aug., 1922.)—The paper commences with a notice of previous work on gas suspensions in liquids. Quincke studied the motion of air-bubbles under an electric field and found that in water they moved towards the positive pole, but in carbon disulphide and turpentine towards the negative pole. McTaggart [Abs. 958 and 1863 (1914)] verified Quincke for water, but found no motion of air-bubbles under an electric field in the pure alcohols, methyl, ethyl, propyl, and isobutyl. In the present research the plan has been to make preliminary investigations into the charge on air-bubbles in pure liquids, with special reference to badly conducting ones. The apparatus used has been of the McTaggart type and is fully described in the paper. Under the conditions employed, air-bubbles were found to show no cataphoresis in the following liquids:—Methyl, ethyl, and butyl alcohols, xylol, benzene, toluene, bromobenzene, benzyl alcohol, benzaldehyde, aniline, cinnamic aldehyde, ethyl malonate, lactic acid, oleic acid, ethyl acetate, and turpentine. The results on turpentine are not in accordance with those obtained by Quincke. It was not found possible to trap an air-bubble in acetone and such volatile liquids as carbon-disulphide. In impure acetone, foreign matter moved towards the positive pole. In distilled water, air-bubbles moved towards the positive pole; in impure benzene, towards the negative pole. In "pure" nitrobenzene air-bubbles moved to the negative pole, whilst in the impure substance the motion may be to either pole. The solution of an air-bubble in methyl alcohol under an electric field previously noted by McTaggart was confirmed. H. H. Ho.

2477. *Experiments on the Ignition of Gases by Sudden Compression.* **H. T. Tizard and D. R. Pye.** (Phil. Mag. 44. pp. 79–121, July, 1922.)—Previous work by one of the authors has shown that when a mixture of a combustible gas or vapour with air is suddenly compressed, explosion may take place after an interval the duration of which depends on the temperature reached by the compression. This interval of "delay" before explosion may be of the order of one second in cases where the temperature reached is only just above the ignition temperature. The object of the present experiments is to test a theory connecting the "delay" observed with the effect of a rise in temperature on the rate of combustion, i.e. with the so-called temperature coefficient of the reaction. The variation of pressure during and after compression—from which the corresponding temperatures are calculated—is recorded by means of an optical pressure indicator of the Hopkinson type, and pressure–time records correct to about one per cent. could be obtained. An example is given above, where the horizontal line is the line of atmospheric pressure, A is the beginning of compression, B the point of maximum compression, and C the explosion. The curve in the top left-hand corner is the cooling curve of the products of combustion.



The three substances tested are heptane, ether, and carbon-bi-sulphide, mixed with oxygen. The values obtained experimentally for the "delay" are in good agreement with the curves obtained from the theory developed by the authors. This theory shows that the interval between the end of compression and the explosion must depend on three factors: (*a*) the compression temperature; (*b*) the temperature coefficient of the reaction; (*c*) the rate of loss of heat to the walls. The results are discussed in their relation to the theory of chemical reactions. By quantitative measurements of rate of loss of heat near the ignition temperature, and of the delay before explosion occurs, it seems possible to gain some real insight into the mechanism of homogeneous gas reactions. The "radiation" theory of chemical reactions is shown to be inapplicable to the results of the experiments given in the paper. T. B.